

Bell Towers and Bell Hanging

AN APPEAL
TO
ARCHITECTS

By

Sir Arthur Percival Heywood, Bart.

THE Architectural Association Library.

RULES.

1.—During the Session the Library shall be open from 10 a.m. to 7 p.m. every day, except Saturday, when the hours shall be from 10 a.m. to 4 p.m.

N.B.—The Library will be closed from Good Friday to Easter Tuesday inclusive, and upon Christmas Day, Bank Holidays, and certain other days stated in the Calendar; and at 6 p.m. upon the evenings of the *Conversazione* and Members' *Soirée*.

During the Recess the Library shall be open every day except Saturday, from 10 a.m. to 7 p.m.

2.—Every member whose annual subscription is not in arrear may borrow one volume at a time, which must be returned before another is issued to him. Letterpress and plates bound separately will be considered as one volume, and by special permission from the Librarian two or more volumes of the same work may be issued together. No book shall be kept longer than 14 days unless a renewal has been obtained.

3.—Any book may be registered for renewal if not required by another member. Members wishing to renew by post card must post in sufficient time to ensure delivery before the Library closes. Should a second renewal be desired, the application must be made in person, and the book produced. Books may be once renewed by telephone.

4.—A borrower shall produce his pass for the current Session if required, and should see his name entered in the register, and on returning a book should see that the entry is cancelled.

5.—Books due for return on days when the Library is closed must be returned on the first following day when it is open.

6.—A fine of sixpence shall be paid for every week, or portion of a week, that any book is retained beyond the above-mentioned periods; and if the book be applied for by the Librarian, and be not immediately returned, the amount of fines that may have accrued shall be doubled.

7.—Arrears of fines shall be reported to the Council, and members whose fines are unpaid shall not be allowed the use of the Library.

8.—A borrower shall be responsible for the safety and good condition of the book borrowed until it has been returned to the Library and the entry in the register cancelled; and in case of loss or damage he shall replace the book or pay such fine as may be assessed by the Library Committee, or if required by the Committee, shall furnish another copy of the entire work of which it is part.

9.—A borrower shall not trace in ink or with a hard pencil, nor apply compasses to any illustration, and shall not make a note or mark by writing or otherwise in any book; also he shall not lend any book, and if he is found to have done so he shall be liable to be debarred from using the Libr.

10
as sh
pecu
offer
list f

ACCESSION No.

11 6140 REF.

CLASSIFICATION No.

18 729.365

BOOK STORE

WITHDRAWAL APPROVED
BY THE AA COUNCIL

Architectural Association



54041000206150



Digitized by the Internet Archive
in 2022 with funding from
Kahle/Austin Foundation

BELL TOWERS
AND
BELL HANGING

BELL TOWERS AND BELL HANGING

AN APPEAL TO ARCHITECTS.

BY

SIR ARTHUR PERCIVAL HEYWOOD, BART., M.A.

*President of the Central Council of Bell Ringers, and of the
Midland Counties Association of Ringers; Member of the
Ancient Society of College Youths, London; the Yorkshire
Association; the Oxford Diocesan Guild; the St.
James's Society, London; the St. Martin's
Society, Birmingham; and of other
Ringing Associations.*

WITH CONTRIBUTIONS BY

EDWIN H. LEWIS, M.A.,

E. ALEXANDER YOUNG, A.R.I.B.A.,

AND OTHERS,

AND

AN APPENDIX.

Published with the sanction of the Central Council of Ringers

BY

LONGMANS, GREEN AND CO.

39, PATERNOSTER ROW, LONDON

FOURTH AVENUE AND 30TH STREET, NEW YORK

BOMBAY, CALCUTTA, AND MADRAS

1914.

BOOK STORE

PRINTED BY
BEMROSE AND SONS LIMITED,
DERBY AND LONDON

PREFACE.

I HAVE been induced to compile the following pages by the extraordinary spread of scientific change ringing during the last forty years, and the consequent impetus given to the erection of new bell-towers, the instalment of new "rings" of bells in existing towers, and the extension, re-casting, and re-hanging of old ones, along with which has supervened a complete revolution in the methods of tuning and hanging bells, conducing materially to musical effect, to the ringers' comfort, and to a saving in the cost of repairs.

The widespread desire, however, for an effective weight of bell-metal, not infrequently in towers too contracted or too weak to safely carry it, together with an immensely increased amount of ringing, has resulted in many cases of structural damage.

Preface

A considerable proportion of architects have concluded that such mischief is largely due to the modern methods of bell-hanging, and it is with the purpose of endeavouring to disprove this conclusion, and to explain the conditions under which a peal of bells can be satisfactorily hung and rung, that I venture, with the support of the Central Council of Bell Ringers, to publish this pamphlet. Any success which may attend the effort will be largely due to the valuable contributions of my coadjutors.

In case any reader may care for some more general information on the subject of bells and ringers, I offer this in an appendix.

A. P. H.

The Athenæum,
June, 1914.

CONTENTS.

PREFACE	- - - - -	2
I. INTRODUCTORY	- - - - -	1
II. THE INTERNAL ECONOMY OF A BELL-TOWER	-	8
III. BELL-FRAMES	- - - - -	29
IV. SUMMARY OF SOME EXPERIMENTS	- - -	54
(By Edwin H. Lewis, M.A.)		
V. ON THE DESIGN AND STABILITY OF BELL-TOWERS		76
(By E. Alexander Young, A.R.I.B.A.)		
VI. BELL-FRAMES AND THE ARCHITECT	- - -	97
(By John H. B. Hesse.)		
VII. TOWERS FOR BELLS	- - - - -	103
(By the Rev. Charles D. P. Davies, M.A., F.R.A.S.)		

APPENDIX.

VIII. BELLS, BELFRIES, AND RINGERS	- - - - -	107
(A Paper read at the Brighton Church Congress, 1901, by Sir Arthur Heywood, Bart.)		
IX. EXTRACTS FROM THE REPORT OF A COMMITTEE OF THE CENTRAL COUNCIL OF CHURCH BELL RINGERS ON THE PRESERVATION AND REPAIR OF BELLS, FRAMES, AND FITTINGS, 1892	-	124
X. CORRESPONDENCE ON CHURCH BELLS WHICH APPEARED IN "THE TIMES," 1899	- -	157
XI. REPORT TO THE CENTRAL COUNCIL OF RINGERS ON THE CONDITION OF OUR CHURCH BELLS, 1906	- - - - -	175
XII. BELL RESTORATION AND PRACTICAL ADVICE	-	181
(By Edward P. O'Meara, sometime Master of the Ancient Ringing Society of College Youths, London.)		

ILLUSTRATIONS.

	FACING PAGE
PONTYPRIDD PEAL	43
WIMBORNE ST. GILES PEAL	48

I.

INTRODUCTORY.

NOTWITHSTANDING the increasingly expressed dislike to the ringing of church bells in populous centres, it is remarkable how our dozen or so of bellfounders, and perhaps as many more who confine themselves to hanging bells, seem to get plenty of orders. The proposal to install a ring of bells, or to increase the number of existing bells in a tower, is almost always extraordinarily popular, although it is no less extraordinary how soon, after completion, pride in and care for the new acquisition evaporate. However, the fact remains that there is no slackening in the demand for bells.

The purpose of this pamphlet is to make an earnest appeal to architects that they would weigh more carefully the expert views of bell-hangers and ringers upon highly technical points in connection with bell-hanging, in which an immense advance has been made during the last thirty years.

Bell Towers and

Few of our leading architects take the trouble to study the nature of this advance, yet few of them can afford to disdain the growing influence of the engineer on almost every species of building work. But the proposals of bell-hangers and ringers, mostly based upon sound engineering principles, only too often meet with contemptuous rejection. *Crede experto.*

I want to show how unfortunate it is that architect and bell-hanger cannot work more appreciatively together.

The bell-hanger may be, and occasionally is, a dangerous man to be allowed a free hand in a church tower. His proposals should be submitted to, and have the approval of, a qualified architect who has personally examined the tower—if possible, in his company.

Church authorities, however, whether from motives of economy or in deference to the wishes of the bell-hanger, not uncommonly allow the latter his own way. Now, both church towers and bell-hangers vary in excel-

Bell Hanging

lence. A capable bell-hanger in a sound tower will be pretty sure to produce satisfactory results. Either a less able bell-hanger or a more delicate structure is liable to involve subsequent trouble. An incompetent bell-hanger dealing with a frail tower almost certainly works mischief.

It is worth while to examine the reasons which lead the best bell-hangers to prefer to do their work independently of an architect. Somewhere about the year 1880 a ringer, a capitalist, and an engineer started as a firm in the bell trade. They took stock of existing practice, and found that, beyond some improvement in workmanship, the method of hanging bells had been little changed for some two hundred years. They realised that a peal of bells hung to be rung—that is, to be swung through complete revolutions—was a delicate and complicated piece of machinery, and that to obtain the best results it was necessary to treat this from an engineer's point of view.

At least twenty years previously timber had been wholly discarded for such structures as

Bell Towers and

bridges, while possibly forty years had elapsed since the substitution of metal for wood in the framework of almost every sort of machinery. The firm argued that, to produce a ring of bells that would keep in good ringing order, the timber bell-frame must be replaced by an iron one, and that wood, with its unceasing expansion and contraction, warping and twisting, loosening and decay, must be replaced by metal in all parts except those, such as wheels and stays, requiring to be especially light; in fact, that the installation of a peal of bells should be that of a thoroughly well-designed and executed piece of machinery.

Not unnaturally, while the principle was right, mistakes were made, and the first hanging of bells in metal frames was not perfect. Then, unfortunately, the firm, from other causes, gave up business, and for a time no other bell-hanger took up the new ideas.

I remember, about the year 1885, urging upon the late Mr. John Taylor, then the head of the eminent firm of bellfounders at Loughborough, the necessity of eliminating from

Bell Hanging

bell-hanging the disturbing influence of timber beams and frames by substituting iron or steel wherever possible. He expressed some doubt as to the feasibility of framing up ironwork under the confined conditions obtaining in most church towers. However, his firm very soon made a speciality of metal bell-frames, in which at the same time other bellfounders were also experimenting.

At the present day all the leading firms in the trade, I believe, have accepted the soundness of eliminating timber, and, by preference, supply iron frames, but, it must be confessed, of varying degrees of excellence.

From the very first our leading architects discountenanced the substitution of metal for oak, and, with few exceptions, their objections have been up to now scarcely, if at all, modified. As a consequence, a bell-hanger is not sorry if he is allowed to do his work in the tower free from supervision and almost certain restriction, although his business instincts will lead him to accept such supervision with a good grace if it is imposed.

Bell Towers and

This want of mutual understanding between the architect and the bellfounder is unfortunate. With a long and practical experience in building, I see clearly that architects are keeping themselves well abreast of modern advance in regard to most of the collateral trades connected with their profession—witness the now common use of steel skeleton framing—but in regard to bell-hanging they adhere to the text-books of a bygone age.

What is the result? Where the bell-hanger is accorded a free hand, he, not being necessarily a building expert, may so arrange and fix his girders and frames as to damage, or even imperil, the tower. Particularly is this likely to happen with the less experienced man. On the other hand, if his design is submitted to the criticism of an architect, the latter, careful of the structure, and unaware, perhaps, of some of the important details of modern bell-hanging, imposes conditions which make it difficult, or even impossible, to install a thoroughly satisfactory ring of bells.

The purpose of this appeal is to plead with

Bell Hanging

architects who undertake the design, alteration, or repair of towers in which a peal of ringable bells is to be or has been installed, that they will, for the good of the structure as well as for the due attainment of its purpose, endeavour to acquaint themselves with what, in the estimation of experts, is the best practice of to-day in regard to these expensive musical instruments.

Mr. Edwin H. Lewis, who is a ringer as well as an engineer, and who is obtaining very interesting and, in certain points, unexpected results from his careful experiments, confirms in the main my own experience. The views also of Mr. E. Alexander Young, as both ringer and architect, support most of the contentions put forward in this pamphlet, as do the opinions of my other contributors.

II.

THE INTERNAL ECONOMY OF A BELL-TOWER.

A TOWER is doubtless a fine opportunity for a competent architect, and he will desire to make the design beautiful according to his own ideas. If it is to contain only a single bell, or a clock with perhaps quarter chimes, the architect can evolve his elevation with a practically free hand. If, however, the structure is to form the setting of a ringable peal of bells, which may range in value from three hundred pounds to as many thousands, it is surely right that the internal arrangement shall be such as to secure the best musical results and reasonable convenience of manipulation. Strange to say, a bell-tower built on these lines is almost unknown. But the reason is easy to trace. Most usually the lower stage of a tower is open to the building to which it is annexed, either as a western entrance or as the central meeting-point

Bell Hanging

of nave, choir, and transepts. It follows that this lower stage will be lofty. The ringing chamber will, of course, form the next stage; above that will come the clock chamber, if a clock is to be provided for. In any case, an intermediate chamber is required, for reasons to be subsequently explained, though its height can be materially reduced where there is no pendulum to be dealt with. Lastly, there will be the belfry, which is open to the roof or spire.

Now, in this class of tower, in nine cases out of ten, there is insufficient height available from the ringing floor upwards. The height of the ringing chamber, for reasons of safety and comfort, should never be much less than twelve feet; fourteen is better, and enough. Too great a height involves a frame of rope guides. The intermediate chamber may be cut down in extremity to three feet, where no clock is to be installed. Its purpose is to modify the sound of the bells to the ringers, whose vocation, when there is only a single floor between ringing chamber and belfry, is

Bell Towers and

well-nigh insupportable. A further purpose, for which a somewhat greater height is acceptable, is to gain space in which to "draw" the bell-ropes out of the vertical, so that, when the arrangement of the bells does not permit of the ropes falling naturally in a true circle—a most important point for good ringing—they may be deflected to satisfactory positions.

In regard to the wooden "spouts," as the trunks through which the ropes are led from the belfry to the ringing chamber ceiling are termed, it is worth attention that, if these are not to act as sound-tubes, their continuity should be broken in the intermediate chamber—most conveniently by leaving uncovered a foot or more of one or two of the sides of each spout. The greatest care must be taken, in these spouts, to ease off all salient corners and ragged edges. Where the change of direction of a rope is abrupt, a rubbing piece of pear or equally tough wood should be fitted, and all nails and screws having their heads within the spouts must be well sunk,

Bell Hanging

so as to obviate any chance of their being laid bare by the grooving action of the ropes. It is, further, most important that the circle of ropes should run "clock-wise"—that is, that each ringer should have the next heavier bell to his own upon his left hand, and not upon his right.

If the intermediate chamber is required to accommodate a clock, a height of from eight to ten feet, according to the requirements of the pendulum, is necessary. Nothing spoils a ringing chamber more than the intrusion of the bob of the pendulum through the ceiling with a clumsy or no containing case. And when, as in a London tower in which I have rung, the pendulum swings in the middle of the ringing chamber, interfering with a proper sight of each bell-rope, the limit of inconvenience has been reached.

Another detail requiring attention is the shaft, or tunnel, for the clock weights. With good management the weights may often be arranged to depend from a point sufficiently high up in the belfry to obtain the necessary

Bell Towers and

run without their going below the floor of the intermediate chamber, thus avoiding a casing, always an eyesore, and often an impediment in the ringing chamber. But that floor on which the run of the weights terminates must be constructed with extra strength at the point where, should a wire break, a weight would fall. In addition, a strong box, full of sawdust, some two or three feet deep, and of suitable size, should be fixed, to absorb what may be an impact of many tons if a weight breaks away at any considerable height.

Incidentally, I may mention that a tower having a good peal of ringable bells is better without a clock, unless one is urgently required; nor do I imagine that any architect would regret to forego an appendage which is generally an eyesore on his elevation.

The objections from the ringers' point of view to a clock are the complication of hammers, spindles, wires, and springs which are introduced among the bells, making access thereto more difficult, and involving risk of

Bell Hanging

injury should anything go wrong with a spring, or the steeple-keeper forget to lift off all the hammers before the bells are raised for ringing.

We have now arrived at the final stage of the tower, the belfry, of which the floor should be preferably of concrete or asphalt, to minimise the transmission of sound, and defy injury from such rain or snow as a high wind may drive through the openings.

Immediately above this floor, but at a height from it of not less than two feet, should come the main girders, upon which the bell-frame—or, as architects often term it, the “bell-cage”—will rest. The method of securing these girders within the walls and their arrangement will be dealt with in the section on bell-frames. Assuming that the upper face of the main girders is about four feet above the belfry floor, the height from this floor to the bearings in which the bells rotate will be eight feet, more or less, according to the size of the tenor bell. Again—and I desire to direct very particular attention to

Bell Towers and

this point—when a bell is “set” for ringing it rests mouth upwards against the “slider.” At each stroke it makes a complete revolution in alternate directions, coming to rest always in the inverted position. It is just before this inverted position is reached that the clapper strikes, so that when a bell is “rung,” its note, given off mainly close to the lip or brim, is diffused in annular vibratory rings—after the manner of the ripples from a stone thrown into water—principally in a horizontal plane, and, where the bells are all hung in one tier, at a height of from ten to twelve feet above the belfry floor.

Now, in the large majority of towers, the sills of the belfry windows are within three or four feet, or even less, of the floor. As a result, the sound-waves from the bells pass directly and freely into the outer air, and thus the maximum of noise—if that is the desideratum—is obtained. But a peal of bells is a grand and costly musical instrument, which, to be effective, requires to be arranged with a proper regard to acoustic principles.

Bell Hanging

The fatal drawback to hanging bells on a level with the belfry windows is that, on whichever side of the tower an auditor may stand, he hears the voices of the bells hung on that side in undue preponderance over the rest, and harmony is destroyed. Further, until bellfounders take to putting hard-wood plugs into all clappers, which is much to be desired, to stand near such a tower while the bells are ringing is to be subjected to a torturing din of deafening and anything but musical sounds.

The ideal tower to produce the perfection of bell-music would be one completely open at the top and with no windows. Unfortunately, the necessity of protection against weather makes such an arrangement impracticable; but let us get as near it as possible.

There would seem to be no reason why the central part of a tower roof should not be raised three or four feet above the level of the rest, leaving a reasonable passage round the inside of the parapet; the sides of the raised part to be louvred throughout, and the

Bell Towers and

parapet of a height sufficient to act as a screen.

In this connection I may recall a curious incident related to me by an old Hertfordshire squire, an enthusiastic ringer, who took a friend to hear the celebrated bells in the beautiful Lavenham tower. As they approached the church, the bells, by arrangement, were ringing, and the squire remarked that he had always thought these bells among the finest, but never had he heard them give forth such exquisite music as now fell upon their ears. When they arrived at the church, they found that the tower roof had been removed for renewal.

The main point to be borne in mind is that the greater the distance through which the sound from the upturned bells can rise before it leaves the tower, the softer and more melodious are the tones, nor does this checking and diversion of the sound-waves appear to affect materially their carrying power. A particularly good example, among many, is the fine tower at Loughborough, with its peal

Bell Hanging

of ten bells, tenor 30 cwts., where the long lancet windows reach almost from the floor of the belfry to the roof. I remember the appalling noise in former days as one listened in the churchyard to the ringing. Subsequently all the windows were built up at the back of the louvres nearly to the springing of their arched heads, and the change was miraculous. Now one converses under the tower with perfect comfort, and the bells sound soft as a musical-box; yet at the station, half a mile away, they seem as clear as before. It was here that ten stout and keen ringers brought to a successful conclusion, in the year 1909, a peal of 18,027 changes in 12 hours and 18 minutes, the longest and finest performance in the annals of change-ringing, which not only reflects immense credit on a band who could, without food, persevere in an undertaking of that inordinate length, requiring throughout an undivided mental application more strenuous than in whist, but also on the patience of the numerous near residents.

Bell Towers and

A tower, therefore, should be so arranged that the sills of the belfry windows are two or three feet at least—six or eight feet if possible—above the rims of the upturned bells. If this is impracticable, then the windows, inside the louvres, should be built up to a sufficient height with solid stone or dark brick, at least nine inches in thickness, and preferably more. The greater the height of the belfry roof above the bells the better, and, if there be a spire, the more openings in it the more effective will be the musical result.

A word about louvres. The very worst for a bell-tower are those which came into fashion some half-century ago of two or three feet in length, fixed at an angle of not more than thirty degrees from the vertical, and overlapping each other by nearly half their length. This class of louvre not only shoots the sound down into the churchyard, but also entirely blocks its upward course. Louvres in belfries should be at an angle of forty-five degrees, not exceed six to nine inches in

Bell Hanging

vertical height, and be set so that the top edge of one louvre is exactly on a level with the bottom edge of the one above. Overlap is not necessary. Snow will but rarely blow in, and is harmless in small quantities, while the sound is given as nearly a free exit as is possible.

That a large reduction of the belfry window openings, obtained by bricking them up, materially lessens noise and improves the music, is well established. A similar result has, in some cases, been effected by fitting, at the back of the louvres to a suitable height, boxes containing some non-conducting substance, or even wooden shutters only; but the results of these and other makeshifts have shewn themselves to be very uncertain. An arrangement of louvres which permits of their being opened and closed, like the slats of a Venetian blind, has been advocated, but its effectiveness is questionable.

In all belfries every opening should be entirely covered with stout galvanized wire-netting of three-quarter inch mesh. If,

Bell Towers and

however, the tower be situate in a town, or in any neighbourhood where the air is impure, copper netting is advisable.

A word may be said as to towers of which the lower stage does not form part of the open church. Ringing may, in such cases, be done from the ground level, although, when the draught of rope exceeds some fifty feet, the handling of bells requires considerably more skill.

But, notwithstanding that this arrangement gives ample scope for a thoroughly effective planning of the upper stages, it is curious how often the bells are still forced up to the level of the belfry windows, to the needless detriment of their musical effect. Fifty years ago that ardent reformer of ringing, the Rev. H. T. Ellacombe, urged continuously the advisability of bringing the ropes and ringers down to the ground floor, often in sight of the congregation; but rather with a view of eliminating the then frequent potations of the ringing chamber than with any idea of improving the music by, at the same time, lowering the bells.

Bell Hanging

A material objection to a ringing chamber open to the church is that, in change-ringing, although, if no mistakes are made, the only vocal sound will be the occasional call of "bob" or "single" from the conductor, yet, in the event of a trip, a helpful hint has often to be given, hastily and with no uncertain voice, thus transgressing the wholesome prejudice against breaking, by any talking, the peaceful silence that precedes Divine service.

With regard to the approach to ringing chamber and belfry, the most convenient form is the spiral stone step, which should not be less than two feet wide, or the ringers' Sunday coats—often their only tidy ones—suffer. It is well that the steps should be carried up to the belfry. Nothing is more inconvenient, on the frequent occasions when the steeple-keeper has to go aloft from the ringing chamber, than for him to have to climb a ladder and make his way through one or two trap-doors. In such inconvenient towers the bells are often sadly neglected. A ladder, also, is much in the way in a small chamber.

Bell Towers and

These spiral steps, however, are often a grave source of weakness if made in an angle of the tower wall without any extra thickness, and the method of placing them in an external excrescence forming part of the wall is greatly preferable. Care, too, should be taken that the steps themselves are of hard stone. Common gritstone wears away at an incredible rate, yet it is almost invariably used, and in no very long time becomes inconvenient, and ultimately dangerous. Again, the height from the nose of the step to the soffit above should have a vertical measurement of seven feet. Where six feet only is allowed, one can comfortably ascend, but, in coming down, the head must be thrown back, with the occasional result of removing the skin from the tip of one's nose.

Attention should also be paid to the lighting—often neglected—of the stairway, and to the glazing of its loop-holes. Much wear and tear of the ringers' clothes will be avoided if the walls, to a height of five feet above the noses of the steps, be treated with

Bell Hanging

three or four coats of stone-coloured oil paint.

The question of the strength of towers to resist the strain of ringing is further treated of in a later section, but I may now mention, as I am dealing here with the arrangement of a bell-tower, that a high and wide opening in its eastern wall often proves a source of weakness, particularly if the north and south walls are also pierced.

Some architects prefer to leave a straight joint between a western tower and the main building. Where bells are rung, it will be usually impossible to keep such a joint closed. If the foundations are good, and the tower is allowed plenty of time to set before being carried above the contiguous walls, there should be but little chance of settlement, unless the height is abnormal. The weakness due to a spacious eastern arch is, of course, immensely reduced by a firm bonding of the tower walls with the rest of the edifice; and, whatever the strength of the tower, its oscillations will be materially lessened by a firm

Bell Towers and

incorporation with the adjoining masonry, if this be of anything like a solid character.

I have mentioned that the belfry floor, being to some extent exposed to the weather, should be waterproof. The remaining floors may be constructed of ordinary joists and boards. If, however, the floor of the ringing chamber forms also, as is usual, the ceiling of the lowest stage of the tower, and if part of the seating of the church is under or near it, the continuous rattle of the ropes during ringing, even where matting is provided for them to fall on, may prove a considerable nuisance, and a double floor is desirable. Of course, should the ceiling below be vaulted with stone or brick, no such precaution is necessary. The floor of the intermediate chamber should be filled between the joists with sawdust, and, if further deadening is required, rough hair-felt sheets, an inch at least in thickness, may be laid upon the joists, the floor-boards being nailed over them. If the height of the intermediate chamber be less than about six feet, it is better approached

Bell Hanging

by a trap-door in its floor than from an external stairway, should there be one, for it will be rarely necessary to enter it. If, however, there is no such stairway beyond the level of the ringing chamber, an easily-mounted step-ladder must be arranged, so that the steeple-keeper may get quickly through the intermediate chamber to the belfry. In this case there will, of course, also be a trap-door in the belfry floor, with a second step-ladder thereto. I would, however, urge that the absence of a proper stairway, at least to the belfry, and preferably to the top of the tower, is a permanent and serious inconvenience.

It is to be remembered that, in the centre of each floor, there must be a framed opening large enough to pass the biggest bell. These can be filled up and finished just as the adjoining floor and ceiling. Only in some rare eventuality will these openings be needed.

The ringing chamber should have a ceiling of lath and plaster. On no account must it

Bell Towers and

be boarded. In fact, the less of panelling or of any sort of woodwork there is in this room the better, for it is essential to good ringing that here the bells shall be clearly and individually heard, which they never are where there is reverberation.

The ventilation of this chamber is a very important matter. Ringers have frequently to stand for three or more hours at a stretch with their backs to the windows, from which it is, therefore, desirable that there should be as little draught as possible. The best plan, probably, is to have the upper part of the lights to open inwards in hopper form; and the windows are most convenient when they are a fair height from the floor. Where this cannot be managed, fix hopper ventilators of, say, one square foot in area of opening in at least two opposite walls a few inches below the ceiling.

The floor is sometimes covered with linoleum, which sweeps nice and clean, but there should then be a mat for each rope to fall on. I prefer myself cocoa-matting, laid down in

Bell Hanging

loose strips, covering the whole floor. It certainly accumulates dust, but it can be rolled up and the floor swept. When there is much ringing, it is well to sprinkle it liberally from a rose-spouted watering-can, which is good for the matting, keeps down the dust, and gives a cool, pleasant atmosphere.

The provision within a tower of washing-basin and urinal is a vexed question. They are undoubtedly an advantage, particularly if ringers attend Divine service after ringing, as they should do. On the other hand, in my own tower at Duffield, where, for thirty years, whenever I have been in residence, I have rung at both the Sunday services and afterwards have gone straight into church, we have done very well without either convenience.

There is no objection to a neatly-arranged basin in a corner of the ringing chamber, particularly if a water supply and waste-pipe can be fitted. A urinal within the ringing chamber is an abomination. Only is one permissible when it is possible to get from

Bell Towers

the ringing chamber on to some secluded part of the church roof, where the necessary arrangement can be made in open air. The want thereof is more acutely felt in a town tower than in the country.

III.

BELL-FRAMES.

IN the previous section I have given some reasons for preferring metal bell-frames to timber ones. Only those who have had to keep the latter in order know the difficulty of securing reasonable rigidity, especially in the case of old frames, where the sap-wood has decayed and many of the tenons have become loose.

A prominent architect has publicly stated that oak for bell-frames is more lasting than metal. The argument seems to be that there are plenty of oak frames which have stood two hundred years or so, of which the timber is still sound. The answer is that, while the heart-wood may be so, much of the external face has perished, and tenons especially have worn hopelessly loose, and such frames cannot be either deemed or made really efficient. In endeavouring to effect repair,

Bell Towers and

angle-plates, straps, and bolts may be freely used, but these have usually only a partial success.

The driving of wedges between tower walls and frames is stringently forbidden, and properly so, by architects. But bellfounders can quote innumerable instances of the defiance of this instruction. (Mr. John Taylor tells me that in 1912 he visited seventy or eighty towers where there were timber frames, and that in nearly all of these he found wedges driven between the upper part of the frame and the walls.)

They will also point out that by far the most prolific cause of injury to towers is this wedging, which authorities cannot, or at all events do not, stop. Even worse is the thumping of the walls by the upper timbers of a loose or weak frame when there is insufficient clearance. I will give one remarkable instance. St. Hugh's tower of Lincoln Cathedral was deemed frail, and, with the object of avoiding all strain, even so great an architect as the late Mr. Pearson

Bell Hanging

had the "ring" of eight bells hung in a frame which was built up from the ground on massive timber uprights seventy feet high, heavily cross-braced in every direction. Of course, this erection, which was a foot or so clear of the walls, oscillated hopelessly, and when I inspected it some twenty-five years ago, I found most effective wedges driven in on all sides between the upper part of the frame and the walls. These bells have now, fortunately, been rehung in a properly designed frame.

It should be understood that, where a frame, of whatever kind, is perfectly "taut," the strain upon it of ringing the bells causes only a springing of its parts, which is less in proportion to the excellence of materials and design, and that the strain exerted by a revolving bell is in no sense a *blow*, but mainly—so far as it affects the structure of the tower—a lateral pressure, occupying something over a second of time between initiation and extinction, both of which are gradually, not suddenly, effected. This

Bell Towers and

pressure is exerted alternately in opposite directions at intervals of approximately two to three seconds, according to the weight of bell. If, however, any part of the frame should become loose, so that the slack members jerk to and fro under the revolutions of the bells, the frames will convey to the walls, more or less directly, according to circumstances, not a mere gradually varying pressure, but something in the nature of a definite shock, harmless, perhaps, in strong towers, but, in weak ones, mischievous.

No doubt there are timber frames that do not give trouble, but these are usually kept well screwed up and are not very old. They are, in my experience, the exception.

Now a metal frame, properly designed and constructed, should not ever become loose in any part, however much neglected; and, whatever objection may be urged against the use of iron and steel, the fact that frames of these materials are now preferred and installed in the large majority of cases makes it clear that the days of timber frames are numbered.

Bell Hanging

Before considering the best forms of metal frames, it may be well to point out that the contention that the tone of bells is impaired by being hung therein has never been substantiated, and there appears to be no more objection on this score than there is to the heavy castings contained in a modern grand piano. Again, I would recall the fact that, at the moment when the principal musical vibrations are given off, the bell is in the inverted position, and there is no part of the frame anywhere near the sound-bow whence the sound issues, except in a top-stayed frame, and even in this there is nothing appreciably impeding.

With regard to corrosion, which, we are assured by one of our leading architects in a pamphlet on the care of churches, makes a metal frame shorter lived than one of oak, one need only point to the complete displacement of timber in all exposed permanent structures where metal can be used. It may be contended that these are kept regularly painted, while metal-work in a church

Bell Towers and

tower, like a bell-frame, is often shamefully neglected. As a matter of fact, except where the atmosphere is impure, the corrosion of unpainted metal-work *under cover* is negligible. Cast iron never sensibly corrodes; wrought iron is nearly as resistant; and steel, the most susceptible of the three, is freely used by all modern architects and engineers in an overwhelming proportion of the important permanent structures of to-day. It may be remarked that where the somewhat higher price of silicon steel is not a bar, its remarkable resistance to atmospheric corrosion, as compared with ordinary steel, may lead to its wider use in structural work.

No doubt, in towns, steel, and to a certain extent wrought iron, suffer from the attacks of acids in the air. But if anyone will examine some of the iron-work, mainly bolts and straps, in the old mediæval roofs, these will be found, as a rule, very little wasted, and it is unlikely they were ever painted. Of course, a little care in well painting every

Bell Hanging

seven years or so will ensure an infinite life to a metal bell-frame in any atmosphere.

I now desire, as a preliminary to reviewing the various methods of modern bell-hanging, to refer to the best ways of fixing the girders upon which the bell-frame rests. Oak beams were, in the past, universal. The objection to these was, and is, that, however carefully they were arranged, they rarely effected any tying together of the walls of the tower. Either they were merely built into the masonry, in which case sap-wood and shrinkage assured an early loosening of any initial adhesion between beams and masonry; or they rested on an offset or corbels, with or without an intervening timber sill, and in no way secured to the fabric, when they were free to exert a thrust on the walls wholly unabsorbed by any compensating cross-tying thereof.

I submit that, to support an oscillating piece of machinery such as bells in their frame, the first essential is some device, not only adequate to carry and resist the requisite

Bell Towers and

weight and strain, but also arranged to firmly hold together the four surrounding walls. This can be best effected by a framework of metal girders, preferably of wrought iron rather than steel, for the reasons already indicated. This framework must be so designed as to tie rigidly the whole thickness of the walls. In the case of a brick tower it is sufficient to build in the ends of the girders, to which suitable transverse flanges have been rivetted; but in the more usual stone edifice, in which, whether brick lined or no, the bonding between the inner and outer faces is always far less reliable, it is essential, by bolts and plates sunk back into the outer casing, and covered by thin slabs, to ensure that there shall be no possible rending of the masonry.

To this end it is necessary that the union be not only that of two opposite walls, but also of the remaining ones. It is not easy to devise a metal frame to fulfil these conditions. The more usual plan is to set the bell-frame on four or more girders running

Bell Hanging

in one direction; but by far the soundest way of overcoming the difficulty, and one which obviates the necessity of through bolting, is to build in, at each corner of the tower, a diagonal girder, entering the walls, according to the size of the edifice, at from three to six feet on each side of the angle, and all but reaching the outer faces; then upon these to bolt the bell-frame, of which, in such case, the lower members must be sufficiently strong to act also as supporting girders, and take the form of a square framework of external dimensions sufficiently less than the internal area of the tower. Thus all strain upon the bell-frame is transmitted wholly to the neighbourhood of the angles, which are manifestly the strongest part of the structure, particularly where it is of considerable area, and, in addition, the diagonal bearers act as through bonders without requiring bolts. Whatever arrangement of carrying girders is adopted, it is essential that the whole shall be so rigidly cross-braced as to prevent the slightest

Bell Towers and

independent horizontal movement of any member.

A word in regard to corbels and offsets as supports to the carrying girders. In the case of corbels, a square frame of nearly the same size as the interior measurement of the tower is usually laid upon them, and on this rest the main beams. If there is no bonding of either frame or beams into the walls, the arrangement is bad, for thrust is exerted against individual sides of the tower without the linking effect which would resolve half the thrust into inward pull on the opposite wall. If there is adequate building in of the girder ends, there is no purpose in corbels or offsets. I observe, however, that some experts who advocate such building in suggest that, at this level, the tower walls may well decrease in thickness. To this I demur, and would urge that the walls be carried up their full thickness to a point at least three feet above the tops of the carrying girders, and, preferably, to the sills of the belfry windows. The weight of this extra thickness of masonry

Bell Hanging

is valuable in securing a better holdfast to the girder ends, and in absorbing, by its mass, the transmitted pressure when the bells are being rung. Where H frames, hereafter adverted to, are employed, and their upper tie-bars are secured, as they should be, into the walls at a height of some six or eight feet above the main girders, it is highly advantageous if the full thickness of wall can be carried well above this top framing.

Having secured a thoroughly rigid bed for the superincumbent bell-frame, and one firmly incorporated with the tower walls, the design of the actual bell-frame has next to be considered. As bearing on this, I would premise that, in a majority of the towers in which bells are hung, the latter are too many or too big, or both, for the available area.

Here let me digress for a moment to explain that I entirely recognise that the heavier a good "ring" of bells, the finer their effect, and also that, from a musical point of view, there is no comparison between a "ring" of eight and any less number. The complete

Bell Towers and

octave gives the *ne plus ultra* of effect in ringing, particularly if the tenor bell is something like 25 cwts. Ten and twelve bells produce a greater body of sounds, but, as the scale in both cases ceases to be true, the strictly harmonic result is inferior. Further, with these larger numbers, the difference in strength of voice between the biggest and smallest bells becomes so accentuated that the notes of the latter are insufficiently heard. The better the bells, the more noticeable, usually, is this defect.

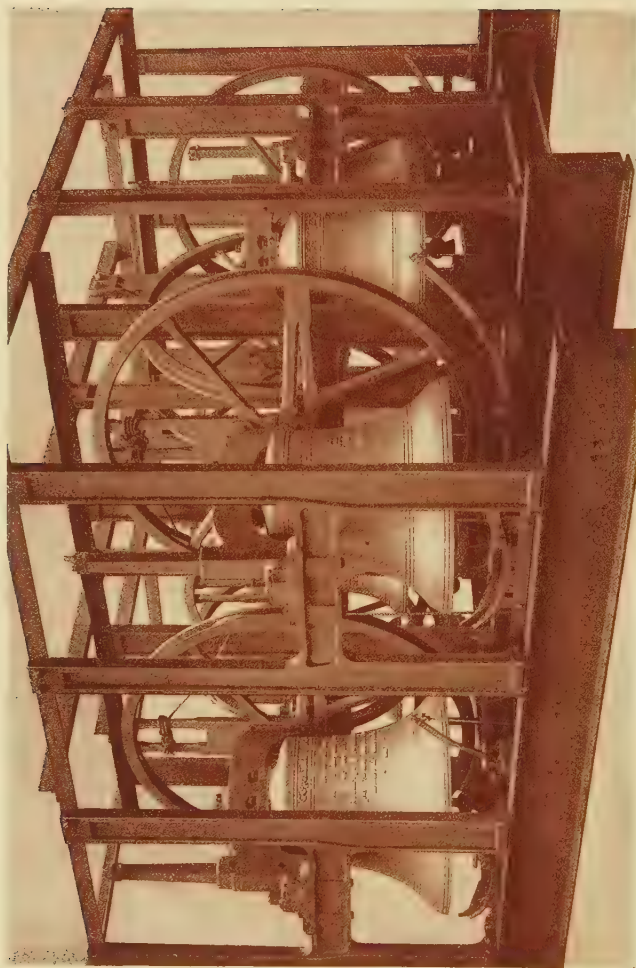
Here, however, is a technical question with which we are not concerned. All I wish to insist on is that unless there is ample area of tower it is a mistake to install more than eight bells, and even this number, however desirable, should not be hung unless it can be done without undue cramming. Over and over again have I seen towers where there is but an inch or two between the outside of the bell-frame and the walls, and where, especially with timber frames, the material has been perilously reduced because the bellfounder,

Bell Hanging

either at his own instance or that of his clients, has unwisely supplied too big or too many bells.

As bearing on this, it is to be noted that a metal frame, occupying materially less space than one of oak, gives greater liberty. Scarf joints, in those members of a frame to which the bell bearings are secured, often necessary for obtaining "bell-pits" of varying width, are, in timber, not only bulky but essentially weak; whereas, in metal, the requisite form can be given without appreciable loss of space or strength.

Where there is insufficient room in a tower to hang the desired bells on one level, it is not unusual to "hoist" one or more to an upper tier. If the frame, in such case, be of timber, there should be a separate set of carrying beams, *built into the walls*, upon which the "hoisted" bell or bells may be directly hung; for these latter should only be the light ones, and the beams can be strutted from the lower frame. Where the frame is of metal and of the H type (to be



PONTYPRIDD PEAL.

EXAMPLE OF METAL "H" FRAME.—*Messrs. John Taylor & Co., Loughborough.*

Bell Hanging

Again, if the mouths of "hoisted" bells, when in their inverted position, are, as is often the case, above the principal window openings, their voices will not tell outside with the necessary strength, and the musical effect of the whole "ring" will be impaired. If, however, there is no escape from hoisting, it is most essential that the bells so dealt with should be the smallest ones of the peal in their natural order; but it must not be lost sight of that, owing to the less space occupied by a metal frame, its adoption will enable more or heavier bells to be hung satisfactorily on one level than if timber be employed. Moreover, however excellent the design of a two-tiered frame, the strain on the tower will always exceed that of an equally good single-tiered frame.

Coming now to the various types of metal bell-frames, Messrs. John Taylor & Co., of Loughborough, have kindly supplied me with illustrations of the two leading designs. The first, illustrated opposite, is that of the so-called H frame, in which the axes of the bells

Bell Towers and

lie on the cross-bars of heavy H castings. Engineers are well aware that cast iron constitutes by far the most rigid base for moving machinery, and that the heavier the castings, and the more truly their mass is disposed in the direct line of strain, the steadier the machinery will run. I may here express regret that A castings, which were the first form tried, have been largely discarded. They transmit the strains much more directly and are in all ways more scientifically correct than the H form, the substitution of which is due merely to its greater convenience in construction. Without doubt, as knowledge of the subject advances, the superior merits of the A form will be recognised.

With either form of casting the tops are all tied together by a comparatively light framework of bars, and these, on each side of the tower, should have extensions terminating in angle plates, which should be firmly cemented far into the walls. It not infrequently happens that the architect will

Bell Hanging

not permit the bell-hanger so to stay the upper part of the frame, but it is to be insisted on that these ties are effective in bonding together the walls as well as in checking the development of frame oscillation. In Section IV. Mr. Lewis has given a comprehensive summary of the results of his elaborate and most carefully conducted experiments on the oscillations of bell-frames and the effect upon the tower. His conclusions are, broadly, those of the late Lord Grimthorpe, distinguished, if not always appreciated, both as architect and engineer, who in a brief letter to *The Times*, reprinted in Section X., strongly advocates the rigid attachment of bell-frame to wall.

These experiments speak for themselves, and I fail to see how any architect, with sufficient knowledge of mechanics to follow Mr. Lewis's clear reasoning, can avoid the conclusion that we must revise many of our former views on the subject.

There has always been in many minds doubt as to whether it is desirable or not to

Bell Towers and

arrest, by means of rigidity of frame and the firm attachment thereof, both above and below, to the tower walls, the development of the oscillatory strains engendered by revolving bells, but it would now seem to be sufficiently clear that any spring in a bell-frame develops cumulative forces which press on the masonry with greater, and occasionally far greater, energy than in the case of a rigidly connected frame where cumulation does not take place.

By way of illustration of the value of Mr. Lewis's investigations, I may instance the case of two bells of approximate weight, hung in adjoining pits with their axes parallel, and swinging in the same plane. Hitherto it has always been considered that if these were roped on opposite sides, so that, in ringing, they swung in contrary directions, the forces developed would to a great extent neutralise each other. Experiments and calculations have shewn that this view is quite wrong, and that, so arranged, the forces developed by the two bells will be cumula-

Bell Hanging

tive, so that, in order to secure the minimum of strain, two such bells should be roped and swing the same way. This sounds somewhat of a paradox, but I am satisfied it is incontestably true.

Besides the greater risk of injury to the masonry, there is this further serious objection to springy frames, that, in them, the bells go more heavily and cannot be so accurately controlled, even by the best ringers. As a result, the ringing is uneven, known technically to ringers as "bad striking"; in contradistinction to "good striking," when the bells speak in absolutely regular time.

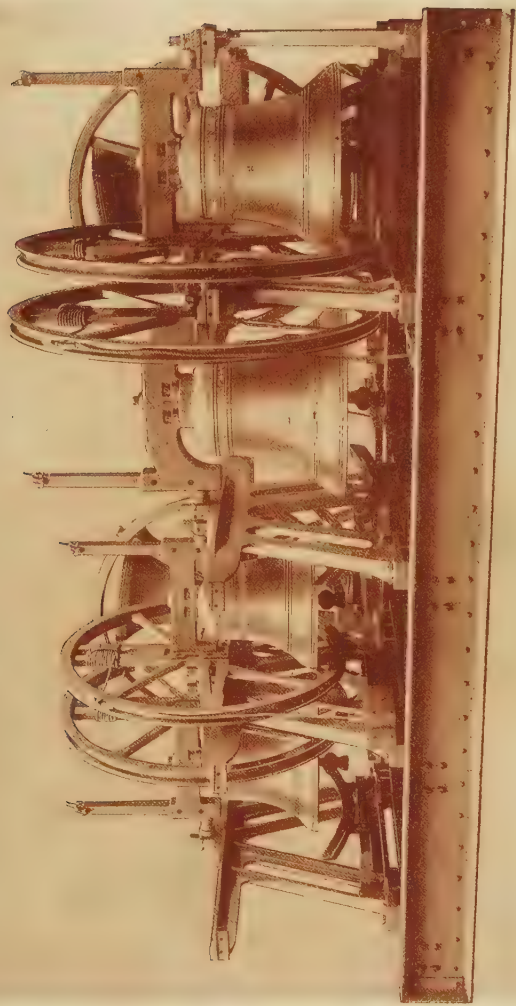
It may be well to mention a curious argument put forward by a great architect, recently, to a friend of mine who was advocating rigid frames in preference to springy ones. "You will not persuade me that a blow from a gloved hand is not preferable to one from a bare fist." But, of course, the real question is whether the feeble blow of the bare fist is not far less felt than the

Bell Towers and

tremendous forces which reside in the gloved hand.

Owing, however, to the persistent attachment of many architects to the old principle of a frame secured only at its base to the walls, Messrs. Taylor have produced in metal what they term a "side frame." This, to some extent, follows the lines of the old timber frames, and is shewn in the facing illustration. The makers do not esteem it so highly as an H frame, but the views of their clients have to be considered. Nevertheless, just as metal frames are steadily displacing those of oak, so, with the advance of knowledge, will the top-stayed frame be a feature of future scientific bell-hanging.

I now desire to direct attention to Mr. Lewis's calculations as to the best methods of arranging bells in a frame. He takes a "ring" of eight to illustrate his conclusions. He is not the first to notice the twisting effect on a tower that may take place, particularly if the two heaviest bells are hung against one wall and swing in the



WIMBORNE ST. GILES PEAL.

EXAMPLE OF METAL "SIDE" FRAME.—Messrs. John Taylor & Co., Loughborough.

Bell Hanging

same plane. This was a very frequent arrangement in the past, and can be shewn to be the worst possible. I strongly suspect that this twisting strain is responsible for many of the cracks in masonry attributed to direct thrust of the frame, because the tower has not the same elasticity to absorb this twist that enables it to retire under thrust. It is difficult to understand why pinnacles and other light details of the upper structure of a tower or spire should, as is sometimes the case, be partially disintegrated, merely by the slow oscillation of the tower. It would seem far more likely that such mischief is due to the twisting strains that are undoubtedly set up under certain arrangements of the bells.

However that may be, we are learning that, to cause the least strain on the tower, bells must not be arranged haphazard. What was, at the time, considered a strange case, occurred recently when a "ring" of bells was rehung in a new frame of apparently excellent design. But the result was unsatisfactory, for the

Bell Towers and

tower oscillated far more, and the bells, or some of them, ran more heavily than previously. It was noted that, as a matter of convenience, the position of the heavy bells was, in the new frame, different to their order in the old one. At considerable expense the original arrangement was reverted to, and all trouble disappeared. Mr. Lewis's investigations shew clearly, for the first time, the true explanation of such cases.

To end now with a few final remarks, whatever be the design of frame, it is important that it should be such that any bell, becoming accidentally detached—a rare but not unknown mishap—will be caught and prevented from falling through the floors below. Also in preparing a frame, if there is room in the tower for further bells, let provision be made for their future addition, either by including in the frame the necessary extra “bell-pits,” or by leaving suitable attachments for them.

Some bellfounders are improving the construction of metal frames by putting in rivets

Bell Hanging

in certain parts in place of bolts, with the result of considerable increase of rigidity. Much more might be done in this direction, and many parts of the frame now bolted together in the tower could instead with advantage be there rivetted in, where there is no expectation of their being again separated. Bellfounders have hardly yet realised that rigidity cannot be obtained in bolted work unless the holes be reamed and the bolts turned to a driving fit. Bridge engineers know well that nothing can surpass good rivetted work, and there is not nearly the difficulty in rivetting in a belfry that has been overcome, for half a century past, in bridge building.

In regard to bolts, there are many in connection with the fittings of the bells, in contradistinction to the construction of the frame, that must persist and that need occasional screwing up. It is usual to provide against the automatic release of these by the proper insertion of split pins. With this latter safeguard, it is eminently desirable

Bell Towers and

to well grease, in the first instance, the threads, an attention which should be repeated at due intervals, and, without which, it is more than common to find it quite impossible to tighten up bolts and nuts that have been neglected for several years.

In conclusion, I may observe that the experience of bellfounders seems to point to the usually inferior character of the internal masonry of existing towers as the prime cause of mischief frequently attributed to the bell-hanger; and my own more limited knowledge certainly entirely corroborates this view. Much thought and capital is being expended at the present day in perfecting every detail of bell-founding, bell-tuning, and bell-hanging, and nothing would more encourage those whose chief aim is to produce the most harmonious "rings" of bells in thoroughly satisfactory settings, than to feel that, in their endeavours, they had the sympathy and goodwill of our best architects.

In that part of this pamphlet for which I am responsible, ringing experts may be

Bell Hanging

disappointed that the technical language appertaining to their art is not made use of. I would, in reply, submit that I am writing, not for them, but with the hope of enlisting the interest of those to whom, though not themselves bell-lovers, it falls to undertake responsibility in regard to the provision or renewal of our bell-towers and bells.

I may further explain that, to avoid prolixity, reference to many details of bell-hanging, with which the architect is not concerned, is omitted.

IV.

A SHORT SUMMARY OF A SERIES OF EXPERIMENTS AND CALCU- LATIONS MAINLY DIRECTED TO EXPOSE THE FALLACY OF THE THEORY THAT ELASTI- CITY IN A BELL-FRAME RE- LIEVES THE STRAIN ON THE FABRIC OF A BELL-TOWER.

By EDWIN H. LEWIS, M.A.

(Formerly Mechanical Science Exhibitioner of Trinity College, Cambridge; Representative on the Cambridge University Guild of Ringers on the Central Council of Bell Ringers; and Member of the Ancient Society of College Youths, London; the Chester Diocesan Guild, and of other Ringing Associations.)

THE following is a statement, without proof, which, however, I have fully worked out, but which is too lengthy and technical for insertion, of the formulæ from which may be calculated the horizontal and vertical forces acting on a tower, due to the ringing of a peal of bells hung in a rigid frame. Then I give a short summary of results obtained by experiments made at Loughborough. These confirmed the theory as given in the formulæ. They also showed that a well-built tower

Bell Hanging

behaves just as a spring would behave when similar forces were applied, and, further, that any degree of springiness in a frame tends to increase the force which acts on the tower.

If a rigid body revolve about a fixed horizontal axis under the influence of gravity only, starting from rest in a vertical position, the horizontal reaction at the axis

$$= \frac{Mgh^2}{h^2 + k^2} \left\{ \frac{3}{2} \sin 2\Theta - 2 \sin \Theta \right\} = H$$

and the vertical reaction

$$= \frac{Mg}{h^2 + k^2} \left\{ 3h^2 \cos^2 \Theta - 2h^2 \cos \Theta + k^2 \right\} = V$$

where Mg = the weight of the body;

Mk^2 = the moment of inertia about the centre of gravity;

h = the distance from the fixed axis of the centre of gravity;

Θ = angle which the plane, through the axis and the centre of gravity, makes with the vertical.

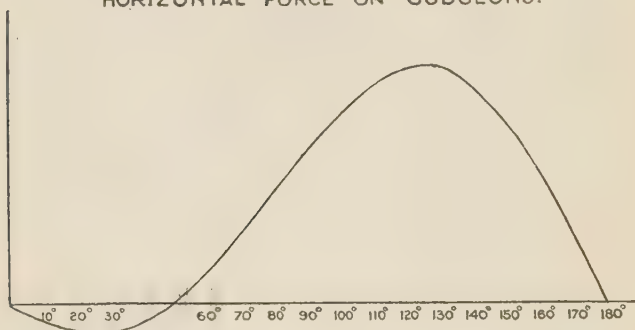
The form of the curves obtained by plotting these two forces against Θ is given on the next page.

H has a maximum value $= 3.0488 \frac{Mgh^2}{h^2 + k^2}$ when $\Theta = 124^\circ 2' 35''$.

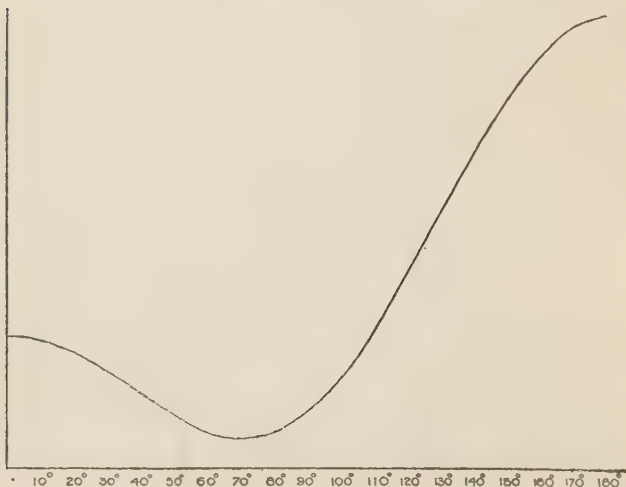
Bell Towers and

V has a maximum value $\frac{5h^2 + k^2}{h^2 + k^2} Mg$ when $\Theta = 180^\circ$.

HORIZONTAL FORCE ON GUDGEONS.



VERTICAL FORCE ON GUDGEONS.



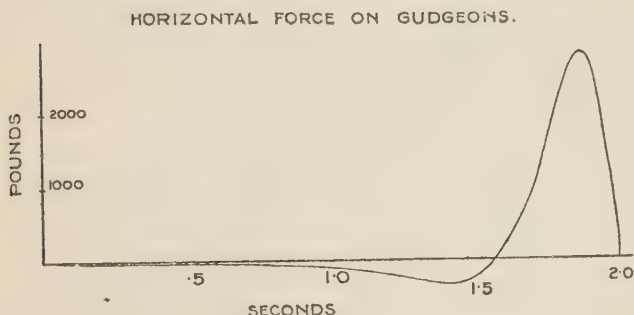
Bell Hanging

In order to determine the resultant action of a number of bells revolving, it is necessary to find a relation between the reaction at the axis and t , the time measured from the vertical position.

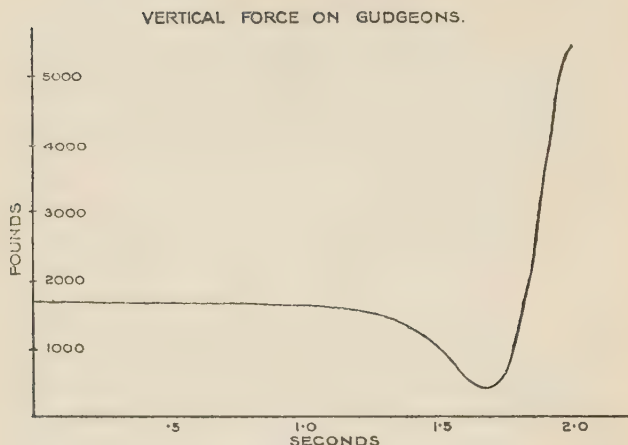
$$t = \frac{1}{2} \int_0^{\Theta} \sqrt{\frac{h^2 + k}{gh}} \operatorname{cosec} \frac{\Theta}{2} d\Theta$$

This is not integrable in finite terms. But a very near approximation can be made by dividing the half-revolution into a number of small periods and taking a value of $\operatorname{cosec} \frac{\Theta}{2}$ in the middle of each period.

The curves obtained by plotting H and V against t are given below:—



Bell Towers and



These curves have been plotted for a bell weighing 1,378 lbs. The headstock, wheel, etc., weighed 239 lbs., and the clapper 35 lbs. h was obtained by measurement, and k^2 by timing a small oscillation, the time of a small oscillation being equal to $2\pi \sqrt{\frac{h^2 + k^2}{gh}}$

The time occupied by a complete revolution is 3.978 seconds, but in actual practice the time of revolution of such a bell would be about 2 to $2\frac{1}{4}$ seconds. The discrepancy is easily accounted for. Nearly half of the theoretical

Bell Hanging

time of the revolution is spent while the bell is within 5° on each side of the vertical position, and when the bell has travelled through 5° , less than .2% of the potential energy has been converted into kinetic energy. It follows that quite a small force applied to check the revolution or to accelerate the initial motion will make the required difference in the time of a revolution without appreciably affecting either the velocity at the lowest point or the maximum forces at the axis.

For the bell already mentioned, the maximum vertical force worked out at 5,424 lbs., which equals very nearly four times the nett weight of the bell. In the case of a "ring" of bells, allowance should be made for all the vertical maxima occurring simultaneously, as is the case when the bells are "fired." But the time at which the vertical maxima occur is not otherwise important. In the case of the horizontal maxima, the time is most important. The time between the occurrence of the horizontal maximum force and the lowest point of the revolution was .137 of a second. This

Bell Towers and

bell was the tenor of a "ring" of eight bells, and taking the weights of the other seven bells, and assuming them all to be similar, the corresponding times for the other bells were:—

·114 second.

·112 „

·114 „

·116 „

·122 „

·126 „

·130 „

It is not strictly correct to assume similarity, because it makes no allowance for the smaller bells being hung further out from the head-stock. But if this allowance was made, the times would be more nearly equal.

The time elapsing between the two maximum values of the horizontal force exerted by one bell varies from slightly less than to slightly more than a quarter of a second. But if these bells were rung in rounds or changes, the bells would follow each other at intervals of a quarter of a second, so that if two bells be rung consecutively in eight-bell time, the

Bell Hanging

second maximum value of the horizontal force exerted by the first bell (as it rises) will occur almost simultaneously with the first maximum value of the force exerted by the second (as it falls). Now if these two bells swing in the same plane, and the wheels be roped on opposite sides, the second maximum of the first will be in the same direction as the first maximum of the second, so that the resultant force is the sum of the two maxima. But if the wheels be roped on the same side, the resultant force at the same moment will be the difference of the two maxima.

This is a most important fact. It follows that the common plan of frame, in which the two tenor bells swing along one side of the frame, puts the greatest possible stress on the tower under ordinary conditions, for not only is the greatest possible horizontal force exerted on the tower whenever these two bells strike consecutively, but that force is exerted near an outside wall, giving the greatest possible twist to the tower.

In order to find out what effect these forces

Bell Towers and

have upon a tower, some experiments were made at Loughborough in November, 1913. Firstly, by means of a suitable instrument, records were taken of the movement of All Saints' tower while the bells were rung in various orders. These records were carefully compared with the theoretical force curves obtained by adding together the force curves of the individual bells. The results showed:

1.—That the tower acted like a spring—that is to say, the initial movement of the tower was proportional to the force applied, and each application of force set up vibration of the tower. This vibration was observed to continue for about 20 seconds after the last application of force.

2.—The tower vibrated with a definite period in each direction. This period was $\cdot 515$ of a second east and west, and $\cdot 624$ of a second north and south. The fact that the east and west walls of the tower were weakened by large arches would account for the slower period north and south, as in that direction the spring would be less stiff.

Bell Hanging

3.—As in the case of a spring, the greatest movement occurred when the period of the applied force synchronised with the period of the spring, or nearly so. This was confirmed by selecting one or two “changes,” which, with the particular plan of bell-frame, would produce this result.

4.—When the applied force was in opposition to the movement of the tower caused by a former application of force, the tower was brought very nearly to rest, but the stopping of the movement of the tower was no more violent than its commencement.

5.—The movement of the tower at the level of the bell-frame was about $\cdot 0036$ of an inch per 1,000 lbs. of horizontal applied force east and west, and about twice that amount north and south. Both these amounts were nearly doubled when the force was repeated, owing to the synchronism of the periods mentioned in 3.

6.—As the tower seemed to act like a spring, it is fair to assume that the movement is due to elasticity in the fabric. In that case,

Bell Towers and

since strain is proportional to stress, the greater the movement of the tower, the greater the stress in the fabric, and the nearer to its elastic limit; and the more nearly the elastic limit is reached, the greater the danger to the tower.

At Loughborough the bells are hung in an A frame, which is as nearly rigid as possible, and it is feasible to calculate the forces due to the swinging of the bells with considerable accuracy. Many architects advocate "spring" frames, not realising that a frame which has any of the qualities of a spring may very largely increase the strain on the tower. By a "spring" frame one would naturally mean a frame which would be displaced, when force was applied to it, in such a way that the displacement from the neutral point was more or less proportional to the force applied; and that, when the force was removed, the frame would return to the neutral position and go beyond it, continuing in a state of free vibration until the motion was stopped by friction. To show the risk of using such a frame, the

Bell Hanging

second series of experiments was made. In what manner the frame is caused to spring does not really matter, except in so far as the period of vibration of the frame would be altered. If there is some form of spring at some point between the gudgeons of the bells and the tower, the forces due to the swinging of the bells may be very greatly increased. In order to demonstrate this, an attempt was made to actually measure the forces developed by a small bell. In the case of a tower it had been proved that the movement of the tower was proportional to the force exerted on it. In this way the movement of the tower could be used as a measure of the forces. With the small bell the measurement was taken by means of a stiff spring, of which the extension was only just enough to make measurement possible. The extension was magnified twelve times by a lever, for measuring purposes. This measuring spring was rigidly attached at one end to a heavy iron bedplate. The small bell was mounted in a rigid cast frame resting on smooth rollers, and the frame was

Bell Towers - and

first attached directly to the free end of the measuring spring. The bell was then allowed to ring itself down from "set." The bell and fittings weighed $25\frac{1}{2}$ lbs. The calculated maximum horizontal force was 37.8 lbs. The measured maximum horizontal force was 35 lbs. Then the frame was disconnected from the measuring spring, and an additional spring inserted between the frame and the measuring spring to represent the spring part of a spring frame.

The bell was again allowed to ring itself down, and *instead of a horizontal force of 35 lbs., a force of 112 lbs. was measured*, which occurred during the third vibration of the spring. This was due to synchronism of the period of the spring and the period of the forces due to the swinging of the bell.

Supposing there was exact synchronism and some means of keeping the bell "up," the bell would fall for the first time and compress the spring so that it exerted a force of 35 lbs. Then, as it rose, the spring would extend till it exerted a force of 35 lbs., due

Bell Hanging

to the energy stored up from the compression, and at the same moment the bell would exert another force of 35 lbs., so that the total force at the end of the spring would be 70 lbs. While the bell was nearly at "set," the spring would be compressed, exerting a force of 70 lbs. As the bell fell again, its maximum of 35 lbs. would coincide with the next extension, bringing the force exerted by the spring up to 105 lbs.; and, as it rose, yet another 35 lbs. would be added. This was the point at which 112 lbs. was observed. The energy stored up in the spring was taken from the bell, so that it rapidly rang itself down. If energy was supplied to keep the bell "up," the force might be increased almost indefinitely if it were not for friction.

By inserting a spring of a different strength, somewhat similar results were obtained; and by loading the frame with weights, which would alter the period of the springs, the forces were in one case diminished and in the other increased.

An extreme case of a spring frame was used

Bell Towers and

in the experiments, but it served to show the correctness of the theory that if a frame is sufficiently springy to store up energy, there is a real danger of the horizontal forces on the tower being very largely increased. If there was movement of a frame without any storage of energy, the frame would be weak, or loose; and when the horizontal forces were reversed there would be an impulse on the tower. But in a rigid frame the changes of force are quite continuous, except for the small shock caused by the blow of the clapper on the bell. This shock causes a small impulsive reaction at the gudgeons; but it acts very nearly in a vertical direction, and is very small, quite negligible in comparison with the forces due to the revolution of the bells.

I desire to tender to Messrs. Taylor my hearty thanks for the invaluable assistance they rendered me in the above experiments.

Bell Hanging

ADDENDUM.

The following calculations are made from dimensions of a bell supplied by Messrs. Gillett and Johnston:—

	lbs.	Proportion.
Weight of bell	1,378	1·0000
Weight of clapper	35	·0254
Weight of headstock, wheel, etc.	239	·1734
Total revolving weight ...	1,652	1·1988
Maximum horizontal force on axis	2,875	2·086
Maximum vertical force on axis	5,424	3·936

The proportions of the weights of the eight bells, of which this bell formed the tenor, were:—

Treble	...	...	...	·3235
2	...	...	...	·3059
3	...	...	...	·3317
4	...	...	...	·3828
5	...	...	...	·5038
6	...	...	...	·6001
7	...	...	...	·7181
Tenor	...	...	...	1·0000
Total	...	...	...	<u>4·1659</u>

Bell Towers and

The maximum horizontal forces acting on the frame for different arrangements of the bells in the frame are set out in a table below. It was assumed that the bells and fittings in each case were mathematically similar, and that, therefore, the horizontal forces exerted by them were proportional to their weights. This assumption rather underestimates the forces exerted by the smaller bells.

The forces calculated are :—

(a) *The maximum possible force.*—This is the sum of the maximum forces due to the separate bells. It may never occur, or may only occur at very rare intervals; but it is always possible for it to occur, and no tower can be considered safe that is not able to resist it.

(b) *The maximum force when “firing.”*—This is the difference between the two sums obtained by adding the separate maxima of bells roped on the same side. It will occur in every tower, but so long as the tower is safe, it does not matter whether this causes the tower to vibrate, because “firing” does

Bell Hanging

not often take place or continue for any length of time. The period is comparatively slow, and will probably not cause any cumulative effect on the free vibration of the tower.

(c) *The maximum force when ringing rounds.*—This is the sum of the separate maxima of the two heaviest consecutive bells, which are roped on opposite sides.

(d) *The maximum force when change-ringing.*—This is the sum of the separate maxima of any two bells which swing in parallel planes, for if they be roped on opposite sides, it will occur when they strike consecutively in the same change. If they be roped on the same side, it will occur when one of the two leads at back-stroke, while the other strikes last at hand-stroke.

The forces are given in terms of the nett weight of the tenor. Where the bells swing at right-angles, the greatest diagonal force is also given. In each case there will also be a resultant couple tending to twist the tower, but its amount can only be calculated when the dimensions of the frame are known. The

Bell Towers and

various maximum forces when ringing rounds and change-ringing are smaller than the maximum possible force; but they should be considered in planning a frame, because they may, through their periodic nature, cause a greater strain on the tower than the larger forces.

Frame I. was planned by the late Lord Grimthorpe in order that the forces exerted by the bells might neutralize each other. The effect is exactly the opposite, and the alternations of force are continuous and large. See pages 74 and 75.

Frame II. is a modification suggested by myself. The force exerted during "firing" is in this case large, but for ordinary ringing the forces of the bells all counteract each other, except the added forces at the back-stroke lead and the unbalanced force at the open lead. See pages 74 and 75.

Frames III. have the bells equally divided; (a) is a very common old plan, and (b) is its common modern form. In the old form the couples due to 2, 3 and 6, 7 would be slightly

Bell Hanging

less than in the modern form. See pages 74 and 75.

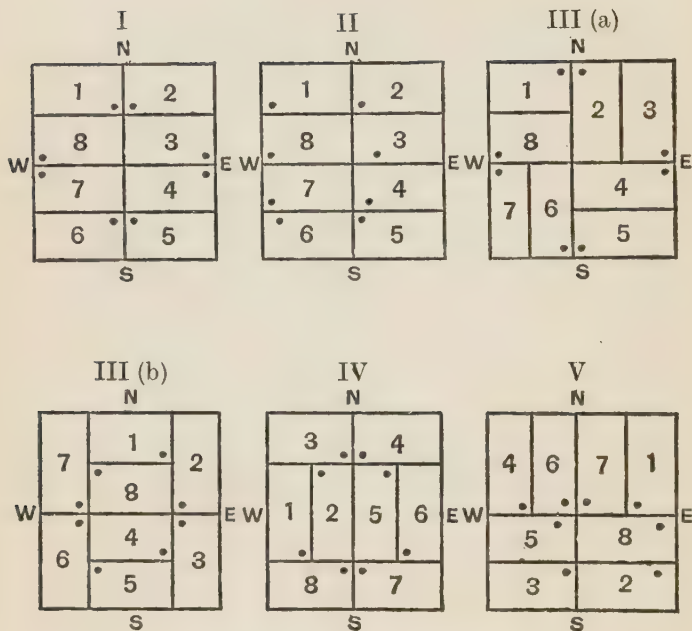
Frame IV. gives the greatest economy of space, and is a favourite with clock-makers who want room for their clock-hammers; but it causes the greatest possible couple to act on the tower whenever 7-8 strike consecutively. See pages 74 and 75.

Frame V. was planned by myself to give the minimum possible forces for ordinary ringing and also the minimum possible couple, the four heavy bells being placed as near the centre of gravity as possible, and all the bells being roped on the same side. But it would require a fairly long draught of rope to enable the ropes to be drawn into a good circle. See pages 74 and 75.

1914.

E. H. L.

Bell Towers and



The dots shew positions of ropes.

See pages 72 and 73.

Bell Hanging

{ E.-W.
... { N.-S.
Diagonal

A. Absolute Maximum

{ E.-W.
... { N.-S.
Diagonal

B. Maximum—Firing

{ E.-W.
... { N.-S.
Diagonal

C. Maximum—Rounds

{ E.-W.
... { N.-S.
Diagonal

D. Maximum—Change-ringing

I.	II.	III.	IV.	V.
8.69	8.69	4.61	5.08	4.46
—	—	4.07	3.62	4.22
—	—	6.15	6.24	6.14
1.86	8.69	1.66	0.48	4.46
—	—	0.19	0.24	4.22
—	—	1.67	0.53	6.14
2.75	2.76	2.76	3.58	2.09
—	—	2.75	2.30	1.50
—	—	2.57	1.95	2.57
3.58	3.58	3.14	3.58	3.14
—	—	2.75	2.30	2.75
—	—	2.57	1.95	2.57

In all cases the maximum vertical force = $16.397 \times \text{weight of the tenor}$; which occurs when the bells are "fired."

See pages 72 and 73.

V.

SOME CONSIDERATIONS AS TO THE DESIGN, CONSTRUCTION, AND STABILITY OF BELL- TOWERS.

By E. ALEXANDER YOUNG, A.R.I.B.A.

(Representative of the London County Association of Ringers on the Central Council of Bell-Ringers, and Member of the Ancient Society of College Youths, London, the Winchester Diocesan Guild, and of other Ringing Associations.)

It may safely be assumed that an architect, when called upon to design a church or any public building, is ready enough to provide such a first-class medium for the emphasis of his design as is a tower or steeple. As a general rule, too, he will make it amply strong enough if he appreciates the uses to which it is likely to be put. He may, of course, be hampered by unreasonable demands or lack of funds, or both, on the part of his clients, and it is necessary sometimes for him to take up a rather strong position. This can only

Bell Hanging

be done in the case of bell-towers by possessing an intimate knowledge of the arrangement and use of the bells, and of the considerable thrust they exert and of the responsive vibrations they may set up in the structure as designed. This knowledge is of the first importance to the architect, though, unfortunately, at present difficult of full attainment. There is, however, the need to make the tower "liveable," having regard to the views of the large number of men (and nowadays also of women) who frequent and use it for the exercise of their art as ringers. This need can, with proper information, be readily met.

The architect has to provide a bell-chamber which must be high in the air, so that the sound of the bells not only travels afar, but is heard thereby to the greatest advantage. This necessity for height accords, fortunately enough, with two other important factors which have often determined both tower construction and design: firstly, the provision of mass to counteract side thrusts; and, secondly, the need to give a public building

Bell Towers and

scale and unity, and to proclaim its position. This is especially so in the case of a central tower. But wherever the tower may happen to be placed in the general design, the question as regards height is of first importance. Once this is settled, then the stresses due to wind and bells may be considered together with the proportions, design, and strength of the structure; and, further, the properties of the materials of which it may be most suitably built.

GENERAL CONSIDERATIONS.

In a brief survey of the points to be considered the practical ones should come first. The bells, presumably of the first importance, are dealt with separately, but the main divisions of a tower or steeple can be outlined in a few paragraphs. The belfry will be at the top, and, at least in urban districts, at a height of 50 to 100 feet. It should contain or have provision for, say, eight bells of fair weight, the area provided being sufficient to take them in on one tier.

Bell Hanging

This means a chamber of at least 15 feet and upwards square. The windows might with advantage be smaller in a town belfry than in a country one; in either case they should be well above the bells, and may advantageously be fitted with sound-control shutters for use in long-peal ringing. The square Norman tower in the centre of Romsey Abbey has the bell-chamber (here a sort of wooden cage) in the centre and on top of a flat roof—an excellent position, as the sound-waves travel out and up. While sound must be allowed exit, it is very desirable that the weather should be kept out. One may suggest an inner partition of sound shutters, and a gang-way around the same between it and the walls. The belfry windows could thus have the ordinary heavy louvres to their lower halves and be open above, the sound-waves escaping at an angle a little above the horizontal. By this arrangement the bells would be sheltered from the weather—an important point, for, alas! they seldom receive much attention after being once hung in the tower. Having kept

Bell Towers and

out the weather, it is necessary also to shut out the birds; therefore all openings must be wired. A wide ledge may occur at the belfry level on account of the decrease in the thickness of the walls. It is advisable to use this offset on all four sides as a support for the bell-frame. This is better than pockets or corbels, since the weight is thus more evenly distributed. The frame, which should be designed as a proper truss, may take its bearing at a number of points upon a teak or oak sleeper or sill on the offset. This sill might with advantage be bedded in mastic or on durable felt, for the vibration may gradually disintegrate mortar, though as to this there may be some difference of opinion. Below this frame is the belfry floor, or "bell-pit," often boarded, but it is probable that a concrete floor here would be both cleaner and more durable. It would certainly provide a good diaphragm to steady and stiffen the walls at this point. Whether it would, however, as some believe, adversely affect the resonance of the bells, is doubtful.

Bell Hanging

The next important division of the tower is the ringing chamber. This comes below and has about the same area as the belfry, the depth from the bell-frame to the ringing floor varying from 20 to 40 feet. About 30 feet probably will give the best results, and will allow of an intermediate chamber of moderate height being planned between the ceiling and the "bell-pit," which may also serve for a clock. The main object of such a chamber is to provide space to intercept the sound of the bells, which otherwise makes it almost impossible for the ringers below to perform their work well. Any transverse "drawing" of the bell-ropes can also be more advantageously arranged in such a space than without it. Unfortunately, many existing bell-towers are spoilt by lack of attention to this detail. The ringing chamber should have at least three sides provided with somewhat small windows, of a total area of, say, not more than one-eighth of the floor-space. Some ringers hold that the windows should be above the line of the eyes, so as to save

Bell Towers and

the dazzle and draught during peal ringing. But, be this as it may, it is an advantage for one window at any rate to give a ready view of the churchyard for signalling upon occasion. As for the walls, they should be as plain as possible, to avoid dust and for the exhibition of peal tablets. The floor should be of plain, strong boarding, and be provided with a trap-door in the centre for the hoisting of the bells. A useful provision and a help to cleanliness is a draw-off tap and sink in one corner. Elderly church cleaners are loth to ascend a lofty spiral stair carrying buckets of water. In this respect it should be remembered that the room is not a mere loft, but that it should be spacious, cheerful, and comfortable, and capable of being so maintained for the large parties of ringers who may upon the occasion of a practice meet there together. To accommodate 20 or 30 ringers a room 20 feet square is none too large, and in this respect it is to be noted as the dominant factor in determining the breadth of a small tower, provided the church plan itself calls for nothing wider.

Bell Hanging

A central tower designed with an inner lantern would, as a rule, except to intercept sound, have no chamber in it coming below the ringing room ; but a western tower, or any similar one springing from the ground level, would, if the bells are at any considerable height, have a further space below, either to be thrown into the church or to give a room for storage or church purposes. The greater the number of chambers, and the less lofty they are, the greater, of course, is the strength of the tower.

An important adjunct is the tower staircase. This is generally a spiral turret stair, which seems very appropriate for the purpose. The riser face of the steps should be on a line radiating from the newel centre, and not tangential to the newel face, as is often the case, giving a treacherous stair, especially for the old or feeble. Ringing is an art practised by both old and young. All stairs, too, should ascend from left to right, if only for the reason that the great majority do so. The width of steps should be not less than

Bell Towers and

2 $\frac{1}{4}$ feet, with a riser as far as the ringing room of 7 $\frac{1}{2}$ inches in height, which may, however, if desired, be increased to 8 inches for the less used stairs above.

MATERIALS.

The accommodation to be provided and the position of the tower on plan being settled, the question of height, proportions, and of materials to be used arises. Dealing with the latter first, in church work masonry is generally assumed as the leading manner of building, though as regards compactness and tensile strength walls of brickwork are probably stronger by some 20 per cent. than those of any but the best executed in stone, the best squared and coursed rubble and ashlar work alone excepted. It will probably be agreed, however, that practice and architectural fitness both prescribe stone, or stonework with a brick backing. If of rubble, then the work should be squared and coursed in long lengths, bedded in strong mortar, well flushed up and solidly grouted, the mortar itself to be of

Bell Hanging

cement and sand at 1 to 4, or stronger, or of good hydraulic lime at, say, 1 to $2\frac{1}{2}$. The mortar is obviously of the greatest importance, for it may prove the weak link in the chain as regards the resistance of the steeple.

As regards the horizontal thrusts produced by the bells, since this largely varies according to their arrangement in the bell-frame or cage, they may now with advantage be considered together.

BELLS AND BELL-FRAME.

A knowledge of the arrangement and action of the bells is necessary in order to appreciate the vertical and horizontal stresses set up when they are rung. An ordinary bell, as cast for a "ring" of 5, 6, 8, 10, or 12 bells, may weigh 2 cwts., or anything between that and 3 tons, and its weight should, in order to obtain a pure and sonorous tone, have a recognised proportion to its diameter and note. Thus for a "ring" of 8 in the key of F, the weight of the heaviest bell, or tenor, would be about 14 cwts., and its diameter some 42

Bell Towers and

inches. This would be considered a rather light "ring." The tenor of "Bow-bells" (a "ring" of 12) is in the key of C, and weighs 53 cwts.

Bells are hung generally and preferably at one level in a "cage" or frame of hardwood or metal specially designed for the purpose. The hangings and fittings consist of a "head-stock" of elm or iron, to which the crown of the bell is rigidly and strongly attached, and which is supplied with steel "gudgeons" at the ends. Upon these the bell swings, being controlled by a light wooden wheel grooved for the bell-rope, which passes around and is secured to the same. This rope, which is of the finest Manilla hemp, is grasped at the end by the ringer, and, in addition, also at alternate pulls grasped by him at the "sally." This is a portion of the rope which has, for some three feet of its length, a wool covering woven in to save the hands. The ringer is thus able to gradually raise the bell until it is poised mouth upwards, and prevented from passing much beyond the vertical by an ash "stay,"

Bell Hanging

which, fixed at its base to the stock, strikes with its free end a "slider" at the bottom of the bell-frame. The bell is thus at rest and inverted, or, as the ringer would say, "set," and may be revolved and set at each blow of the clapper or kept swinging at will.

For bells of, say, 18 cwts. and upwards, the ringers stand upon wooden boxes framed up off the floor. There is thus greater control of the long length of rope, and the "sally" also is kept up off the floor.

It would appear, from investigations which have been made, that the architect should see that his frame can support four times the weight of the bells, and his tower withstand, say, twice the weight of all the bells taken as a horizontal thrust. These forces, unless carefully arranged for, might well exert undue strain.

Thus with a "ring" of 12 bells, all hung to swing in one direction, and with a tenor of 50 cwts., the thrust would be twice the total weight, say 250 cwts. $\times 2$, or 25 tons. This would be oscillating with a period of, say,

Bell Towers and

three seconds each way, and might prove destructive to any but the most massive tower.

To reduce the thrust upon the tower, English bell-hangers have for centuries arranged their bells, as a rule, with the heaviest at the centre, and also with about half swinging at right-angles to the remainder. This is a very rational arrangement, and is still the latest practice.

BELL-FRAMES.

These, it will be seen, are of the greatest importance, and should be subject to the architect's approval. It is certainly one of his functions to know about frames and girders. The tower and frame will then have their due and proper relationship the one to the other.

The best results appear to be attained when from two-thirds to three-quarters of the total weight of bells swing in the direction of the strongest walls.

It will be noted that the bells must be all hung in sequence, and the ropes arranged, as

Bell Hanging

far as possible, to fall in a circle or ellipse on plan, in the ringing chamber below. It is very necessary, too, that they range round "clock-wise" from the treble or smaller bell, as ringers are accustomed to that order, an arrangement which is the rule in nearly every tower.

As to the material which should be used in the construction of bell-frames, the old ones were always of oak. This was only natural under the circumstances, seeing that it was probably supplied from adjoining forests. With the advent of cast-iron and steel, some difference of opinion has arisen as to whether timber or metal should be used for these frames. It is urged by some, probably without reason, that metal robs the bells of their resonance; and again by others that timber warps and twists, and also opens at the joints. Steel has the advantage of being readily adapted to the construction of a light and strong frame. It would be interesting to try the experiment of constructing a frame in teak reinforced with steel rod bracing, the rods

Bell Towers and

being not less than one inch in diameter, and well coated with some approved anti-rust preservative.

ANCIENT TOWERS AND STEEPLES AND THE VALUE OF TRADITION.

A well-known civil engineer, in addressing the members of his Institute, once said that when he was called upon to design an important public structure, he first drew out what his practical experience demanded and what his eye told him was right. He then investigated the principles involved, and if theory demanded more strength than practice, he gave it; but if, on the other hand, it assented to less, he still allowed his original design to stand. So that if the buildings of those who have gone before us have stood the tests of time and use, our experience based upon them is our first asset, and is, further, most valuable to us in considering the design of any similar structures which may have to fulfil the same purpose or use. The architect has to make himself familiar with the steeples

Bell Hanging

of mediæval and renaissance times, which have been fitted with bells for ringing as they are rung to-day, and these buildings will be his best guide. Among them, not the least important are those erected by that great architect, Wren, whose steeples have withstood every test during the past 200 years. So, too, have many of our towers and steeples which have come down to us from gothic times; but, of course, many of these are characterised by their massive proportions, which are rather beyond present-day work, and, indeed, hardly called for. One finds in our old church towers walls whose thickness is one-eighth or more of the tower breadth, thus giving a ratio of solid to void of almost 3 to 1. When these towers are of no great height, they have an enormous reserve of strength, even though built of flint or random rubble.

Taking the English mediæval steeples—*i.e.*, a tower with its surmounting spire—these were generally built for the use of bells, and are an obvious prototype for the revived

Bell Towers and

gothic of to-day. It is much to be feared, however, that the first gothic revivalists of the early nineteenth century copied far more the outward form than they did the interior strength, and are responsible for the just complaint that many of their towers are unsuitable for a "ring" of bells of even moderate weight.

An interesting table might be given of the proportions and areas of some of the principal gothic and renaissance steeples; a general proportion, however, of height and breadth would seem to be about 8 to 1, with the spire springing at about half the height. It is interesting here to note that the statutory height of a circular chimney shaft built in the County of London is limited to twelve times its diameter. These chimneys are, of course, of homogeneous construction, and offer by far the least resistance to the wind which it is possible to obtain. Returning to the gothic steeples, an interesting plate, showing the section of that at St. Andrew's, Heckington, Lincolnshire, is given in Fletcher's Hand-

Bell Hanging

book, and the building described as a typical English church. The tower here has a height of 175 feet and a breadth of 25 feet, or a ratio of about 7 to 1. The walls of this tower are some 4 feet 6 inches thick, and equal the breadth divided by 5.5. There are, of course, many well-known steeples of greater height, notably St. James's, Louth, and St. Michael's, Coventry, both having ratios of about 11 to 1. It is interesting to compare, coming to rather later times, the two famous London steeples of St. Mary-le-Bow and St. Bride's, both erected by Wren in the English renaissance style at the close of the seventeenth century.

Wren, owing to his remarkable gifts, had been able to take the gothic tower and spire and clothe them in the garb of the new style, then, as we know, lately arrived from the Continent, and here, too, he achieved some of his happiest results. Artist as Wren certainly was, he is, of course, yet more famous as a scientist. He may, indeed, as a skilled mathematician himself, have had his interest awakened in the new branch of the science

Bell Towers and

of permutation, which had in his time recently come prominently before the public. This was in the development of the new art of change-ringing, which practically dated from the publishing by Fabian Stedman, the well-known Cambridge printer, of his work *Tintanologia*, in 1667, which he dedicated to the "Ancient Society of College Youths" of London, a fact of which the present members of this Society are justly proud. Be this as it may, there is no doubt that both these towers of Wren's are eminently fitted for their purpose, and approximate very closely to each other in proportion. Each contains a "ring" of 12 bells, hung at a height of about 80 feet, which is about two-fifths of the total height of some 220 feet.

An examination of the plans and sections of the two last quoted churches shows that the ratio at St. Mary-le-Bow is about 6·6 to 1, whilst the walls are in thickness about the breadth divided by 4·4. At St. Bride's, the steeple being loftier, the ratio is about 7·6; the walls, however, remain about the same,

Bell Hanging

viz., 4·3. It is worthy of note that St. Bride's has always had a lighter peal than "Bow," and was probably intended for 8 or 10 bells only. Contrasting these with the mediæval steeples, we, of course, miss the massive buttresses of the latter; but this is compensated for in Wren's typical ones by more massive proportions, thicker walls, and, as a rule, fewer openings.

It should be observed, too, that the sixteenth century ashlar masonry was usually better built than the coursed rubble of the fourteenth and fifteenth centuries. The mortar was probably much the same in both, as Wren's masons carried on the practical traditions of the previous age. As regards mortar and cement, modern work has undeniably a very great and important advantage over the old, especially in its use of Portland cement.

All the old steeples were laced together very liberally with heavy beams, generally of oak, at frequent intervals, the walls thus not being weakened by lofty chambers. The

Bell Towers

lower part was often vaulted, a valuable addition to the tower both for adornment and strength. Openings and voids were sparingly used, the chief of these being the four great windows immediately above the bells; the latter an eminently logical conclusion, for here the tower no longer requires that strength of cross-section which is necessary from the bell-frame downwards. On the æsthetic side, too, the louvred windows proclaim to the onlooker the purpose of the structure, and their beauty and lightness emphasise and contrast the reserve of strength declared by the plainer wall surface below.

It will be seen that there are many points in the above suggestions which will arrest the attention of the architect, and he will doubtless feel sufficiently interested to desire to investigate further for himself. He might, indeed, with considerable advantage to the Profession, be able in this way to help in throwing further light upon the movement of towers when vibration is set up, and the effect of such vibration upon the materials of which it is built.

VI.

BELL-FRAMES AND THE ARCHITECT.

By JOHN H. B. HESSE.

(Mechanical Engineer ; Representative of the Middlesex Association on the Central Council of Bell-Ringers, and Member of the Ancient Society of College Youths, London ; the Oxford, Surrey, and Winchester Diocesan Guilds ; the Irish Association, and of other Ringing Societies.)

UP to within the last twenty to twenty-five years nearly all bell-frames were built of oak or chestnut, and the headstocks were of elm. It seems to have been in the past, and, I am also sorry to say, is still at present in many instances, the idea of many architects that wood is the proper thing to make a bell-frame of, because they say it is better for the tower and better for the tone of the bells.

There is no doubt that the frame that is best for the tower and best for the bells is the cast-iron frame mounted on steel girders, for the following reasons.

A wooden frame is mounted on beams built

Bell Towers and

into the walls, or resting on corbels, or on an off-set, and, involuntarily, the beams work loose in the masonry as years go on, and the frame, resting on corbels or on an off-set, moves. If a beam is carefully examined where it is built into the wall, the mortar or cement round the beam will show generally a crack due to the shrinking of the timber, and eventually it becomes loose. When this happens it is bound to be a greater strain on the masonry round the beam, and loosens it; also a timber frame, unless most carefully watched, will work loose in the joints if it is not kept carefully screwed up, which is the exception, not the rule.

The usual practice of the present day is to mount cast-iron frames on steel girders that are built into the tower walls, with some angle pieces riveted on to the ends to form an anchor into the masonry; or, a better plan, on the end of the girders rivet a steel bolt of sufficient strength, and carry this bolt right through the tower walls to the outside. The nuts of these bolts must be kept below the

Bell Hanging

surface of the outside walls; this means the tower is braced together and held.

The nuts, of course, should be below the surface of the masonry, and faced over with stone or cement so that they do not show on the outside of the tower, or the nuts may be arranged on the inside. These bolts should go through a large stone if possible.

If a massive cast-iron frame is erected on girders as above described, the tower girders and bell-frame are as one unit, and there is no movement of the frame whatsoever.

The expansion and contraction of a steel girder placed under a bell-frame may be disregarded, as the sun-rays do not reach it; in the hottest weather the bell-chamber is cool, but in some cases it has been thought advisable to anchor alternate ends of the girders. For instance, if there are four girders, each girder would be anchored at one end and free the other, two anchors one side of the tower and two the other.

There are many architects who contend that the bell-frame ought to give with the

Bell Towers and

swing of the bell, but it has been proved that a frame that gives with the swing of the bell exerts much more strain on the walls of the tower than one built on modern lines of iron and steel that is rigid, as above described.

One particular case illustrating this that was brought home to me was a lofty tower containing a peal of six bells, tenor 37 cwts., but hung in two tiers, with the treble, second, third, and fourth bells in an old-fashioned timber frame above, and the fifth and tenor in another old timber frame below. The top four bells swung east and west, the fifth and tenor north and south, and when these bells were ringing the sway of the tower was very noticeable indeed.

Two years ago the bells were all rehung in a very massive cast-iron frame mounted on steel girders, and four smaller bells added, making a grand peal of ten. The movement in the tower is now very much less, with ten bells hung on modern lines, than it was with six hung in the old way, and, in my opinion, this is due to the fact that the girders are now

Bell Hanging

bracing the tower together, and the dead weight of the frames and girders help to keep the tower stationary, in the same way that a twenty-ton weight on top of a tall factory chimney keeps it steady in a gale of wind.

With all the peals of bells that have been hung in recent years in iron frames, I have not heard of one authenticated case where the tower has been damaged, and exhaustive enquiries have been made by myself and others.

The same cannot be said about wooden frames. Not many months ago I was asked to inspect a small peal of bells in Somerset that were hung in an old wooden frame. One of the main beams had worked loose in the masonry, and a crack developed, extending several feet, coming direct from the beam. These bells have now been rehung in an iron frame on modern lines and the tower repaired, and the result leaves nothing to be desired.

There are many cases of complaint when people living close under a tower complain about the noise of bells. If architects would

Bell Towers

only remember that all openings for letting out the sound should be well above the bells, there would be fewer complaints.

In towers where the openings or louvres come below the bells, they should be bricked or boarded up with not less than one-inch boards. If boards are used, they should be covered with two layers of roofing felt to at least two feet above the mouth of the tenor bell when set on end.

When a tower is about to be built, the architect in charge of the work would do well to consult with the bell-hanger, and discuss the plans of the tower. By this means the most efficient bell-tower would be the result. The sound should always be driven in an upward direction, and the perfect arrangement would be an opening in the tower roof, about which there should be no difficulty to keep out the wet if properly designed.

1914.

J. H. B. H.

VII.

TOWERS FOR BELLS.

By the Rev. CHARLES D. P. DAVIES, M.A.,
F.R.A.S.

*(Rector of Frethurne, and Hon. Secretary of the Central Council
of Church Bell-Ringers.)*

NOTHING can be more inconvenient and useless than the usual floor, placed close under the bells, necessitating acrobatic contortions of the body when the bells have to be muffled, or when anything has to be done to the clappers or ground pulleys, not to mention that it is almost impossible to keep such a floor clean, and that it becomes a receptacle for old rope-ends, candle-ends, jackdaw sticks, and the like. It is, moreover, always dark. A floor three or four feet lower, with the space below the bell-frame lighted, not only by the large windows above the bells, but also by some smaller ones at the required level, would be lighter, convenient, and cleanly.

Bell Towers and

The clock-room, if any, next below, is most important, and particular attention must be paid to its height, which should be at least seven or eight feet. This for two purposes. For the ropes that have to be drawn out of the perpendicular in order to fall in a reasonable circle, it is most essential that the angles of deflection should be as slight as possible to avoid friction. This is not feasible without sufficient distance between the floors, and there should invariably be a room of sufficient height for the clock and its pendulum. Nothing is more objectionable than a clock, or even part of it, such as a pendulum or pendulum case, blocking up or protruding into the ringing chamber. There should, of course, be windows to light the clock-chamber.

Two considerations are of vital importance in connection with the ringing chamber. It should be of the right height, and properly lighted and ventilated. The correct height is about 12 feet. If lower, it is apt to get close, and if much higher, the draught gets too long,

Bell Hanging

with the annoying liability to "miss sallie." For the proper lighting of the chamber, the essential points are that the light should all come from a level well above the eyes, and that it should be evenly distributed. These points are easily secured by two or three small windows on each side of the tower. Moreover, when there are plenty of small windows opening in all directions, there is opportunity of opening as many or as few as desired, and in the best direction to suit temperature and wind. Nothing is more maddening than darkness, or light coming from too low down, or than one huge window with only one opening pouring rivers of draught, often combined with blazing sun, on the backs of those on that side of the chamber; those on the other side being blinded with the light, and utterly unable to see the faces of the ringers opposite.

One more point in connection with the ringing room is that its ceiling should be of ordinary plaster. A boarded ceiling is too resonant. What is wanted is a ceiling that

Bell Towers

will, on the one hand, minimise the hum, while, on the other, not muffling the sound, so that each bell may be heard as nearly as possible as a single tap. For this there is nothing like a lath and plaster ceiling. All windows in the tower, except in the belfry, should be glazed. The belfry windows should have fine wire-netting over them inside to keep out birds.

1913.

C. D. P. D.

APPENDIX.

VIII.

BELLS, BELFRIES, AND RINGERS.

A Paper read at the Brighton Church Congress (1901)
by SIR ARTHUR HEYWOOD, BART.

I HAVE been asked to open the very wide subject of bells, belfries, and bell-ringers, and the task is not an easy one. Speaking generally, a subject brought under discussion at Congress is one in which public interest has previously been clearly manifested. Now to belfries and ringers the public, including Church authorities, is mildly indifferent. It is a case of "out of sight out of mind." Bells, however, do attract some attention, particularly when rung, but then by no means always of a sympathetic kind. All brain-workers are more or less disturbed, not to say irritated, by a long-continued peal in their immediate vicinity. I have myself at times entered into the feelings of a bygone inhabitant of Norwich,

Bell Towers and

who told the ringers of that city that he wished they "had round their necks what they pulled with their hands"; a view candidly echoed more recently by a Londoner, who, being informed that ringing was a difficult accomplishment, expressed his regret that it was not impossible. Yet a long implanted love of the sound of bells lingers in the hearts of that section of the community which does not suffer from overstrained nerves. Ringing is exclusively an English accomplishment; and, except in English-speaking countries, bells are never hung so that they can be rung in peal. Thus England has come to be spoken of as the "ringing isle," and the sound of bells to be interwoven with many of our joys and sorrows. So it is that, in spite of the objections raised to ringing on the score of noise, no proposal is more generally popular in a parish than that of putting up a new "ring" of bells or adding to an old one. It commonly appeals to all parties, and elicits generous contributions. But once the bells are hung, and the function of dedication is over, in too

Bell Hanging

many cases the interest of clergy, churchwardens, and parishioners begins to wane, and in a year or two the "ring," which, if creditably cast, tuned, hung, and rung, should thenceforth be a standing pride, is, perhaps, denied the small outlay necessary for upkeep, and a gradual deterioration begins. Many of our older "rings" are even in worse case, for long neglect has reduced bells and frame to a condition in which a grave mishap may at any time occur. The splendid tenor bell in Winchester Cathedral was cracked from sheer neglect a few years ago, and its successor by no means equals it. Numberless cases of similar neglect could be quoted. Nor is it the bells only that are forgotten, for ringing chambers are often found to be repositories of dust and dirt. Where bells are well looked after, it is usually at the instigation of the ringers, for Church authorities too frequently do not recognise their responsibility in regard to these by far the most valuable items of church furniture, upon the provision of which hundreds and sometimes thousands

Bell Towers and

of pounds have been spent. It is regrettable that the requirements of bells and the aims of ringers are so little understood by most churchmen, and this is a fortunate opportunity of placing them before you.

I do not propose to touch at all upon the archæological aspect of bells, which is amply dealt with in many elaborate publications, nor do I desire to say more than I am obliged about the actual art of ringing—to use its time-honoured designation—because a speaker who follows me will probably deal with this branch of the subject. I wish rather to give a brief general sketch of the evolution of bell-ringing, in the hope of increasing your interest both in bells and in ringers.

In the early part of the seventeenth century change-ringing was elaborated into a science, and with the Restoration arose a perfect mania for new bells. Ringing became a fashionable pastime, and societies for its practice were formed. It was then that a band of young nobles founded in London one of the oldest of existing ringing guilds, the Ancient Society

Bell Hanging

of College Youths. Somewhat later we read that ladies were accustomed to stop their carriages in Fleet Street and listen to competing peals from the various towers. Again, in most of the older treatises on manly exercises, ringing will be found fully described as a fine combination of physical and mental application. Gradually, however, the pastime lost its interest for gentlefolk, and came to be almost wholly vested in the artizan class, though the music of well-rung bells continued generally popular till the rush of railways and telegraphs began to affect people's nerves, and caused the noise to be regarded as a nuisance. Ringing, however, was too firmly planted to be crushed out by unorganised opposition. You will, perhaps, follow me better if I outline its nature.

It is a physical exercise in which bells from three hundredweight to three tons in weight have to be revolved in accurate time, often for three hours or more at a stretch; a feat in reality more dependent on knack—or, as the horseman would say, on hands—than on

Bell Towers and

muscle. But there is much more. When changes are rung we enter on an elaborate science involving brain-work. Those who stop short of this are known as only "round-ringers," whose abilities differ from those of "change-ringers" very much as the player of "beggar-my-neighbour" differs from the whist player. It is of change-ringers that I am all through more particularly speaking, for it is in change-ringing that the fascination and excitement lie which have always ensured recruits to hand on the art. The change-ringer's ambition is to ring peals; and a peal technically consists of not less than 5,000 changes, no two alike, and rung without pause. If each ringer works correctly to rule, the changes are, so to speak, automatically produced, for none of them knows what the individual changes will be.

The peculiar isolation of the votaries of ringing, the absence of any sort of link with other pursuits, and the obscurity of its queer phraseology, have resulted in the gradual segregation of ringers into a body apart, with

Bell Hanging

a firm freemasonry among its members that prompts them always to befriend one another.

Throughout the early part of the nineteenth century, a period during which the social status of ringers sank low, the art was mainly kept alive by the steady perseverance of the old guilds, chiefly in the large towns. But the then all-pervading vice of intemperance played havoc with ringers, as with other classes. Then came that honoured reformer, the Rev. Henry Ellacombe, who inculcated the totally new doctrine that ringers were Church officers, and that their art should be consecrated to the service of the Church. Good men supported him, many ringers hailed with satisfaction this novel interest in their welfare, and a steady improvement set in. Strangely enough, comparatively few of the clergy followed Mr. Ellacombe's lead; and nothing in the history of ringers is so remarkable as the way in which, during the last fifty years, the large majority have erected themselves, with little assistance, into a highly respectable body. County and diocesan

Bell Towers and

guilds were formed all over the country with the bishops as patrons, and ruled on Church lines. These guilds, which usually hold quarterly gatherings, embrace at the present time nearly the whole area of England, and number between them many thousands of members. In 1890 the need was felt of some central representation, and a council of Church bell-ringers was initiated, consisting of about eighty delegate ringers, many of them clergy, from thirty of the principal guilds. This council meets annually, and its pronouncements have done much to determine points of difference and perplexity, and to weld the various ringing associations into a united body.

One cannot but regret that in the creation of these societies it was, in most cases, the *ringers* who invited the *clergy* to assist, and it is a pity that, while an increasing number of incumbents have extended a helping hand, occasionally themselves becoming proficient in the art, the majority have been content to offer but a lukewarm sympathy, chiefly

Bell Hanging

because it has not occurred to them to master the aims and requirements of those who ring their bells. It was thus that the Church lost a great opportunity, that of annexing, or at all events of endeavouring to annex, as co-workers a body of men numbering probably between forty and fifty thousand, who, with growing self-respect, were laying aside former bad habits, whose interests forced them to support the Church as an institution, but who, for want of Church leading, have not yet come generally to regard themselves as responsible Church officers or the bells as instruments of Church music.

Having now traced the history of ringing to the present day, and thus, I trust, put you more in touch with the idiosyncrasies of its votaries, I will venture to offer a few general suggestions.

First of all, if you are building or altering a church tower, make up your mind definitely whether you require it as an ornamental appendage to the church or as a belfry. If the former, place yourself unreservedly in the

Bell Towers and

hands of the architect. If the latter, submit the plans to a first-rate bellfounder, and let his advice have weight. As a ringer from my early childhood, I have visited many towers, and have never yet come across one designed with the primary purpose of properly accommodating a "ring" of bells. Architects seem to be wedded to two arbitrary and pernicious traditions. The first is that bells should be hung on a level with the belfry windows, so as to let out the maximum of sound. The second, that the bell-frame should be entirely clear of the walls, lest its so-called vibrations should shake them.

Now, except in a very wide and high tower, the result of bells being on a level with the windows is that, on whatever side the listener stands, the nearest are too loud, while the rest are often scarcely audible. The ideal tower would be open only at the top, when the sound would have the freest exit, would travel far, but be soft and equable round the immediate vicinity. Such a tower is perhaps impracticable; but, at any rate, keep the bells as

Bell Hanging

far as possible below the windows. Nor, in fixing their level, must it be forgotten that when they strike they are mouth-upward—that is to say, the clapper-balls are from four to six feet higher when they strike the bell than when at rest. Where bells are already hung, the windows should be solidly bricked up inside the louvres to a height, if possible, of not less than five feet above the highest point reached by any bell. A very small window opening, often less than a fourth of that existing, will suffice. This has been done in several cases with marked success. Wood shutters for this purpose are almost useless. If there is a spire, the more openings there are in it the better. Care should be taken that the louvre slats do not overlap one another. The narrower they are the better. The wide slats now in fashion check the rise of the sound and shoot it down into the churchyard. See that all openings into the belfry are covered with wire-netting to keep out birds.

The bell-frame and supporting girders, as

Bell Towers and

also the stocks of the bells, should be of iron or steel. Use no timber, as it shrinks and twists, requires frequent alteration, and is constantly throwing the bells out of truth, so that they can sometimes with difficulty be rung. The supporting girders should be solidly built into the tower, if possible during its erection, and be arranged to bind the four walls together. The top of the frame, which should be at a level well above the bells, may often with advantage be bolted firmly through each wall. Thus the bell-frame holds the tower together, instead of spreading it, as often happens with the old style of fixing. It is a fallacy that the use of metal for timber impairs the tone of the bells. The distance of the bells from the windows and roof alone affects it. The wider the tower and the higher its windows and roof above the bells, the better they will sound. Timber is to-day a thing of the past in any structure where strength and permanence are required. An independent floor of concrete or plaster must be fixed some two feet below the frame girders, and

Bell Hanging

not less than three feet lower again a second floor, to form the ceiling of the ringing chamber, which should be plastered, not boarded, on the under side. All boarding in a ringing chamber is to be avoided. It makes the bells indistinct, and leads to careless ringing. The chamber should be about fourteen feet high, clear of all obstruction, suitably furnished, and kept clean and tidy. Ringers usually come in their Sunday clothes, and do not care to have them spoilt.

Full details of all clockmakers' work should be submitted to the bellfounder before it is put in hand. Clockmakers often ruin the convenience of a ringing chamber with their clock cases and weight boxes, and imperil the safety of the bells by the reckless way they fix striking hammers and wires. If you have a good "ring" of bells and keen ringers, you will do better without a clock. I know a church tower, lately erected, regardless of cost, by a leading architect, with a fine "ring" of eight bells, where the ringing chamber is so blocked with organ bellows and clockwork, and the structure

Bell Towers and

so weak, that the bells cannot be rung; and I could give numerous other instances of the astounding ignorance or carelessness of those who profess to provide for the needs of bells. As to the best number of bells, the octave is the most perfect. If you can only afford six, at least leave room in the frame for the other two; they will double the musical effect. Ten and twelve bells give a fuller body of sound, but, as the scale ceases to be true, there is a distinct loss of harmony. Also the difference between the big and little bells is accentuated, and the latter can frequently be scarcely heard.

Bells should now always be tuned on the system elaborated recently with such success by the late Canon Simpson. The bell is placed on a species of lathe, and its three principal notes are brought into exact harmony by means of standard tuning-forks. The difference between this and the common plan of chipping by guess must be heard to be appreciated.

Let me, in conclusion, give a few hints on

Bell Hanging

the management of ringers. Try to have your bells rung for at least one of the Sunday services ; for two, if possible, as is the practice in many districts. If ringers meet only on special occasions, there is little chance of getting them to realise that their work is done for the Church. Each church should have its own band. Let the clergy show an intelligent interest in their ringers, and frequently visit the tower. Just as every incumbent professes enough of music to criticise his choir, so he should know so much of the art and aims of his ringers as will enable him to judge of their performances. If the ringing is even and regular, it is good ; if the contrary, bad. It does not require much of an ear to discriminate so far. Let him beware, unless he is young, of learning to ring with the idea of taking the lead among his men. It takes years to make a ringer, and of such not one in four is competent to lead. Peals of five thousand changes are the ringers' ambition. Encourage them as far as possible. If the noise is a nuisance, block up the windows.

Bell Towers and

Prize competitions on church bells are now nearly things of the past. Do not encourage them; but it is courteous to grant the request of a visiting band of competent ringers for a peal on your bells. Every tower must have its rules, which should be concise and observed. Payment at from sixpence to one shilling per man per service, according to the locality, usually works better than voluntary ringing. There should be an annual meeting of the band to settle their affairs; an opportunity for the incumbent, and he should be present in the chair. I do not, of course, presume to offer these hints to those clergy, happily an increasing number, who are already masters of the art of ringing and thoroughly understand the management of a tower.

I will conclude with one question: Why, when there are some forty or fifty thousand ringers in the country whose interests bind them to support the Church, does not the Church make a more widespread and united effort to understand and promote the commendable aims of these men, when, by a

Bell Hanging

sympathetic and effective recognition of their requirements, this great body might be turned into a valuable working factor in strengthening regard for the Church among the masses?

IX.

EXTRACTS FROM A REPORT PRESENTED TO THE CENTRAL COUNCIL OF CHURCH BELL RINGERS BY THEIR COMMITTEE APPOINTED TO DRAW UP A BODY OF ADVICE AND SUGGESTIONS ON THE PRESERVATION AND REPAIR OF BELLS, FRAMES, AND FITTINGS, 1892.

CHURCH bells hung by a really competent and experienced bell-hanger require very little after outlay to keep them in order; but that little is imperative. It is, very generally, taken for granted that they need none. Hundreds of pounds are expended in providing a church with that costly and elaborate mechanism known as "a peal of bells," about the preservation of which the churchwardens probably thenceforth take no thought, until, through neglect, the bells gradually become

Bell Hanging

unringable, or an accident occurs, such as a falling clapper, a broken gudgeon, or a cracked bell, entailing ultimately an expenditure far in excess of the moderate annual sum required to keep everything in proper repair. Even where there are competent ringers, who, for their own sake, look well after the bells, it is common to find that any representation they make as to necessary repairs is quietly ignored by the authorities, or deferred until their funds will permit it to be considered. In the meantime, the mischief reaches a climax, and the churchwardens are compelled to provide a sum often enormously greater than that which would have sufficed at first. This state of things arises, not from any reluctance on the part of the authorities to keep the property of the church in order, but from the ignorance that prevails in regard to the reasonable requirements of bells and ringers. It is the desire of the Council to set forth what these requirements are, and to supply such information on kindred matters as shall be useful to the

Bell Towers and

clergy and churchwardens to whose care the church tower and its valuable contents are committed.

THE PRESERVATION AND REPAIR OF BELLS, FRAMES, AND FITTINGS.

I.—THE BELL-CHAMBER.

It is essential that all openings from the bell-chamber to the outer air should be thoroughly protected by wire-netting, with a mesh of not more than three-quarters of an inch, to exclude birds. The disgraceful condition of bell-chambers where this precaution is neglected is sufficient evidence of its need. No accumulation of rubbish on the floor of the bell-chamber, or about the timbers of the frame, should be allowed; for, apart from the unclean and slovenly appearance of such accumulation, there is considerable risk of a chance match or spark falling upon it, and igniting any waste or rope-frayings that may

Bell Hanging

be lying about. Great care should also be taken to place all tools, spare tackle, and other loose articles where they cannot be jarred or blown among the bells; and, generally, the bell-chamber should be kept in a manner befitting the place where such valuable machinery is erected.

II.—THE BELLS.

With regard to the bells themselves, the greatest precaution should be taken against any of them being cracked. The expression “being cracked” is used advisedly, for it is very rarely that the destruction of a bell in this way is due to any cause but *carelessness*. Bells have been cracked outright, cannons broken off, or some previous flaw developed to a destructive extent, by such causes as striking the bell, when unringable, with a heavy implement held in the hand, or allowing it to remain loose on the stock, or by unskilful hands bumping it against a stay too strong to break. A bell is liable to crack if the hollow worn in the sound-bow by the clapper becomes

Bell Towers and

too deep. To avoid catastrophe, such a bell should be "quartered," or partially turned, in order to bring the clapper in contact with a fresh part of the sound-bow. Chiming hammers and clock hammers are a source of danger, either when too heavy; or, when fixed by careless clockmakers in such a manner as to strike above or below the sound-bow; or, when allowed, by reason of weak or broken springs, to rest on the bell; or, when not prevented by suitable gear from "striking" while the bell is being rung. The details and position of all gear to be erected by the clockmaker should be submitted for approval to, and, after erection, be inspected and passed by, the bell-hanger.

Innumerable bells have been cracked by the mischievous practice of "clocking"—that is, chiming by a rope hitched round the flight of the clapper, a most dangerous as well as slovenly practice, which should be sternly prohibited by churchwardens, and for allowing which, after such prohibition, any sexton or steeple-keeper deserves dismissal. Clappers

Bell Hanging

must not be permitted to drop by wear so as to strike below the centre of the sound-bow, or the result may be fatal to the bell. This drop usually arises from neglecting to keep the pin of the clapper joint well greased. Tuning bells in the tower by chipping is to be deprecated. Above all, no attempt to "sharpen" a bell should be allowed, as the removal of the edge has but little effect in raising the note, and is sure to impair the tone. In order to tune bells satisfactorily, they should be removed to a foundry, and dealt with under a proper machine, the flattest bell being taken as the standard, and the rest reduced thereto. If sufficient funds for removing and bringing back the bells are not available, it may be wiser to abandon the idea of tuning altogether. If, nevertheless, tuning is attempted to be carried out in the tower, it should be done by a founder, and, where possible, by the firm most interested in making the result successful. It would be extremely rash to allow any bell-hanger, who offers to do it, to attempt tuning; so many bells having

Bell Towers and

been irretrievably ruined by the unskilful use of the hammer and chisel.

III.—THE BELL-FRAME.

This structure, on the rigidity and soundness of which the perfect action of the bells will depend, requires frequent examination and attention, more especially if constructed entirely of timber; any tendency to work loose at the joints or on the supporting beams should be checked at once by screwing up bolts or strengthening the angles; a frame which dips, or works laterally, under the swing of the bells is very prejudicial not only to the action, but to the safety of the latter, and often of the tower also. Very old frames are, as a rule, too far gone in decay to admit of preservation or successful repairs, and it is better to make an effort to replace them by new work rather than spend money uselessly on attempts to patch them up. In any case, whatever is done should be done by *a bell-hanger of established repute and experience*. The soundness of the support-

Bell Hanging

ing beams is of vital importance. These are often very ancient, and, where found to be decayed, should be taken out and replaced by new ones of thoroughly seasoned oak, or by wrought iron girders, well bedded and cemented into the walls of the tower. The girders should be left *wholly open to inspection*, and not be covered up by floor or ceiling. Independently of the natural vibration of the tower, there must be no *lateral* working of the frame allowed. Let the supporting beams (or girders), which are either built into the tower or solidly bedded on ledges of the walls, present a level bearing for the frame, and care be taken that the latter rests fairly and solidly upon them on all sides, and is itself properly constructed and braced to resist the strains which the swinging of the bells exert upon it; there will then be little risk of separate movement of the frame or of injury to the tower. Should lateral working of the frame be at any time developed, no attempt to remedy it by wedging the frame from the walls should ever be made; the cause of the

Bell Towers and

mischief should be sought out at once, either in the loosening of joints or the decay of supports, and the proper remedy applied there. To wedge a moving frame from the walls of the tower is to convert it into a battering-ram, to the evident prejudice of the tower, without really remedying the defect. Iron frames, of which many, of various forms, exist, should be carefully examined periodically, to see that bolts and nuts have not loosened or broken; they should then be scraped and cleaned down, and, after thorough examination by a competent man, repainted.

Modern bell-frames are very frequently constructed either entirely of iron, or of a combination of iron and oak, in preference to oak only. When made entirely of metal, it should be of the best *wrought* iron or *wrought* steel. *Cast* iron should only be used in the form of A or H shaped castings, on the crossbars of which the bells are hung. The feet of the castings are bolted to the carrying beams, or girders; and the heads to a lighter frame-work of oak or iron. This

Bell Hanging

makes a good serviceable frame. Modifications of this design, which are thought to resist the strain of the swinging bells more effectually, have their advocates; but iron frames being a comparatively new departure, there is as yet no general agreement as to the form to be preferred. Where economy of space has to be considered, the *wrought* iron frame may be employed with advantage. When the erection of an entirely new frame is projected, the question naturally arises, what form it shall take, and of what materials it shall be made. As different towers require different treatment, according to their dimensions, shape, strength, and the number of bells they are to contain, each case must necessarily be considered on its own merits, and the opinion of competent experts should be sought before any plan is finally adopted. The responsible officials of the County or Diocesan Society will always be found willing to give advice, if asked for it. The value of an iron frame, especially of one entirely of wrought iron (or steel), depends upon

Bell Towers and

excellency of design and construction; a badly-designed iron frame being more open to objection than an average one of oak. The superiority of iron and steel over wood has been so long recognised, and acted upon in every other branch of engineering, that the tendency of the present day among the leading firms is to erect iron, or composite iron and oak, bell-frames rather than those which are constructed entirely of timber. Iron frames do *not* impair the tone of the bells, as it was once absurdly thought they would; and iron is not liable to the warping and twisting, under variations of atmospheric moisture, which is displayed by timber, *the defect of which latter material in this respect is the cause of the majority of heavy-going and unringable bells.* In a well-designed and well-constructed iron frame, therefore, the action of the bells ought to be, and will be, perfect for a great length of time under proper supervision. On the other hand, it is almost needless to say that no iron frame has yet stood for 200 years, although

Bell Hanging

there is no apparent reason why it should not do so. Many timber frames have stood this length of time, and still survive, although it cannot be affirmed that a timber frame will retain its service efficiency unimpaired for many years if neglected ; and, even if watched, it will be always subject to alterations from changes of weather. The form of a new frame and its position will be dictated by circumstances and the judgment of a competent expert. In another section it is suggested that, where practicable, it would be well to place the frame at such a distance down the tower that the mouths of the bells, when raised, may be below the sills of the sound-windows ; but in no case should the folly be perpetuated of erecting a lofty spider-legged frame more or less independent of the walls of the tower, on the top of which the vibrating weight is left to sway and knock about at its will, to the imminent danger of both frame and tower, as formerly in Lincoln Cathedral. Such a plan is directly opposed to the treatment adopted by engineers in

Bell Towers and

erecting heavy machinery in high positions ; yet it has been recommended and carried out by authorities who, one would have thought, would have recognised the rashness of the proceeding. There is this advantage in placing the frame low, that a stronger part of the tower is thus laid hold of for connection with the frame. The uppermost part of a tower is often not only weaker in substance than the lower part, but is often further weakened by wide windows. It is unwise, therefore, to depend, *in every case*, upon this portion of a tower for additional support to a frame, unless reliable advice on the point is first obtained. In some cases of composite frames, not only are the timbers below the A castings solidly built into the walls, but the upper members of the frame are secured to the wall by bolts passing quite through the masonry ; often with good results in reducing the oscillation of the tower and frame, for the tower is thus bound together by the frame, which, in its turn, is stiffened by the tower, the component parts being thus far less liable to work

Bell Hanging

loose. (Example at Loughborough.) The lower members of a frame should be always so arranged as to catch a falling bell, and prevent its further descent—a point not always attended to by the frame-maker.

IV.—THE FITTINGS.

These require regular attention. The bolts which attach the bell to the stock need occasional tightening, and also those which hold down the gudgeon bearings. All fractured bolts should be at once renewed. The pulleys, clapper-joints, and gudgeons need careful lubrication, the latter very frequently (for the gudgeons of heavy bells, castor-oil or Bell's Asbestoline will be found very suitable). When a bell goes heavily, the gudgeons and brasses should be examined; and if so worn as to cause the least joggling, or if they have lost their parallelism, so as to produce an unequal bearing, they should be renewed at once. The ropes should be kept in good serviceable order, and the parts which are most exposed to wear should be

Bell Towers and

black-leaded. The sliders also should be black-leaded, and *not oiled*. A watchful eye, in short, should be extended to everything belonging to the bells. A good steeple-keeper may be expected to attend to all these matters; but none the less would it be a good thing if churchwardens would not take all belfry matters on trust, but *personally* inspect the bells as they do the rest of the Church property. We desire also respectfully to invite archdeacons and rural deans to inspect personally at their visitations, or, at least, make strict enquiry about, the condition of bells and belfries. Should the steeple-keeper report any of the bells as going badly, or the frame as loose, the assistance of a competent bell-hanger should be called in, and *on no account that of a local tradesman*. The amount of mischief that has resulted from allowing those who are not specialists to tamper with the fittings of bells is incredible, and expense will assuredly be saved in the end if the repairs are entrusted to trained hands. It is most desirable, even when there

Bell Hanging

is a competent steeple-keeper in charge, that a "ring" of bells be *thoroughly examined* by a bell-hanger of repute about every *fifth* year, when all necessary repairs should be promptly effected, after which the bells, frame, and fittings should be well cleaned down, and the woodwork and ironwork repainted.

THE MEANS OF MODIFYING AND CONTROLLING THE SOUND OF CHURCH BELLS.

A.—IN THE RINGING CHAMBER.

B.—OUTSIDE THE TOWER.

A.—Bad and slovenly ringing results when the ringers are unable to hear distinctly the clear tap of the clappers of *all* the bells, owing either to too much noise in the ringing chamber, or to the sound of any of the bells being too much subdued.

I.—TOO MUCH NOISE IN THE RINGING
CHAMBER.

To prevent the sound of the bells from

Bell Towers and

being too noisy in the ringing chamber, the ceiling should be *plastered*, and *not boarded*. Not only avoid boarded ceilings, but also walls panelled in wood. All wood-work in the ringing chamber tends to resonance, and to impair the clear tap of the clapper. If the walls of a ringing chamber are wainscotted for the sake of warmth or appearance, the work should be executed in coloured linoleum panels in a slight wood framing, or in some kind of close-woven matting or other non-resonant material. In a noisy chamber, of which the height is not less than 13 or 14 feet, an intermediate floor of 7-inch joists (an opening large enough for the largest bell to pass through being framed in the joists), the whole lathed and plastered underneath, will answer exceedingly well. The distance between the ceiling thus formed and the floor above should not be less than 2 feet 6 inches, and a trap-door should be provided in the ceiling to allow of access to the intermediate space in case of necessity; this trap will also serve to regulate the sound

Bell Hanging

if too much suppressed by the ceiling, and should be, if possible, beneath the smaller bells. In the case of towers of low elevation, in which the ringing floor is necessarily *very close* below the bells, a plaster ceiling may be placed underneath the supporting beams of the bell-frame, and the space between it and the flooring immediately under the bells filled with granulated cork, or lined with "slagwool." Space for a trap-door large enough for the biggest bell to pass through must be left, the passage of the sound through it being controlled by a cork mattress made to fit the space. Wooden spouts for the ropes, bell-mouthed above and below to prevent wear, must pass quite through the intervening space between ceiling and floor above, and be securely fixed. Rope spouts, or channels, should not be allowed to unite two vibrating floors; they should be in two parts, divided transversely, and fixed out of contact with each other. The short wooden tubes which pass quite through a narrow space, as above described, can also be in two

Bell Towers and

halves, fixed out of contact; and, where the space is packed with cork, the tubes can be wrapped round with canvas or felt tightly bound with wire ligatures to prevent the cork dust falling through.

II.—BELLS INDISTINCTLY HEARD IN THE RINGING CHAMBER.

It often happens that the sound of the lighter bells of a “ring” is drowned in the ringing chamber by the more sonorous voices of the heavy ones; more especially is this the case when small bells are “hoisted” above the big ones. This defect may be overcome by fixing wooden spouts, about 3 inches square, from the ceiling of the ringing chamber to the bells that are indistinctly heard. The top of the spout should open into a sound-gatherer (*i.e.*, an open box) as near as possible to the upturned mouth of the bell when set. A slide may be arranged either at the top or bottom of the spout to reduce the opening as desired, and thus control the volume of sound sent down the

Bell Hanging

tube. A superior plan to this is a funnel-shaped galvanized iron bowl inverted close over the upturned bell it is desired to hear, a separate bowl being used for each badly-heard bell; a 3 or 4-inch tube, opening into the bowl above, is curved round and brought down through the ringing-chamber ceiling. If there is a central gas sunlight in the ringing chamber, the air-pipe from this may be made to answer the purpose of the downward tube. Zinc, as a material for these bowls and tubes, is easier to work, lighter, and may be made to occupy less room; but it is not so durable as galvanized iron.

B.—TOO MUCH NOISE OUTSIDE THE TOWER.

In view of the great increase of change-ringing and peal performances of late years, and of the complaints frequently made of the noisiness of bells, the question of the means which can be employed to control the direction of the sound-waves, and prevent them from being beaten down upon houses in the immediate neighbourhood of the tower, has

Bell Towers and

become one of urgent importance. One or other of the following methods of treatment will be found sufficient, according to circumstances, to remedy the evil complained of. Each tower, with its surroundings, must be treated on its own merits; for a drastic remedy, necessary in one case, would be needlessly strong in another.

I.—THE CLAPPERS.

It is very frequently the case that noisiness and harshness of tone in bells is to be accounted for by the fact that they are “over-clappered”; that is, that the weight of the clappers is too great for the weight and thickness of the bells. Examination by an expert will determine whether this is the case in any given instance, and if his verdict is to that effect, one of the first remedies to be tried is *lighter clappers*.

II.—THE SOUND-WINDOWS.

The windows of a bell-chamber are expected to perform two contradictory functions,

Bell Hanging

viz., on the one hand, to keep out rain, and on the other, to allow *free* egress for the sound of the bells. Louvres are almost invariably adopted, with the effect, generally, of pouring the sound-waves in one great volume directly downward into the street below; the louvres, moreover, are often sloped far more steeply than they need be, which increases their driving-down power and intensifies the nuisance. When, therefore, it is found desirable to *modify* the sound of bells in the *near neighbourhood* of the tower, while still allowing them to be heard afar off, the sound-waves must be directed into a proper course for the purpose; that is, they must be allowed free egress either in an upward, or horizontal, direction; and egress with a downward direction must be prevented. Before stating the various methods of treatment which will accomplish this result, it will be well to consider the position of the bell-frame with respect to the sound-windows. According to the fashion which has prevailed from ancient times, church bells are always

Bell Towers and

hung in close proximity to the windows, and at such an elevation that, when "set," their mouths are considerably above the window-sills. No arrangement could be more unfortunate: for the result of it is that, to listeners near the tower, the bells nearest to any window "tell out" on that side above the others, and often sound, by comparison, extremely harsh, because the sound-waves from the other bells are intercepted and overpowered by those proceeding from the bell or bells nearest the listener. This want of equalization in the tone of all the bells, near the tower, is accountable for a great deal of the so-called "noise" of bells; because it is undoubtedly disagreeable and discordant to hear one or two bells persistently prominent above the rest. In the construction of any new tower, or restoration of any old one, arrangements should be made for placing the bell-frame very much lower down the tower, so that when the bells are raised their mouths may be still several feet *below* the sills of the sound-windows; the sound-waves will

Bell Hanging

then rise and distribute themselves more equally on every side. With bells placed as they usually are, the sound-windows must be dealt with, if it is desired to modify the sound of bells. In towns, where the evil is most acute, the *most effectual* way of damping the sound of bells, inordinately noisy in the near neighbourhood of the tower, is by almost entirely blocking up the sound-windows inside with 9-inch or 14-inch brickwork (according to width of windows), rising to the spring of the arch-heads; in the case of a square-headed window, to within a foot of the top. (Examples at Burton-on-Trent and Loughborough.) In country places a milder measure than permanent blocking will probably suffice, and may be found in 1-inch boarding, lined with some sound-resisting material, and filling up the window-space, behind the louvres, nearly to the top. "Slag-wool" is a good and effective material for lining; it will not burn, and can be plastered if desired. *Unlined boards are useless.* This boarding may, with advantage, take the

Bell Towers and

form of *sliding shutters*, mounted on runners fixed to the wall below the sills of the windows; they can thus be closed or opened, at pleasure. Care must be taken, with all kinds of shutters, that no space is left between the shutters and the walls, through which sound-waves can escape to the *louvres*. Sliding shutters are superior to shutters on hinges, and to independent shutters held in place by a button, being so much easier to manage than either, and, with ordinary care, can be kept in working order. (General examples at St. Mary's Cathedral, Edinburgh, Winchester and Lichfield Cathedrals.) Venetian *louvres*, working like the swell of an organ, so as to reverse the usual slope of the *louvre-boards*, and thus throw the sound-waves upward, are also said to answer well.

III.—THE TOWER ROOF.

In the construction of a new tower, which is to contain a "ring" of bells at the usual elevation (that is, the topmost storey, above the sills of the bell-chamber windows), the

Bell Hanging

central portion of the roof should be raised two feet or more above the level of the rest; the sides being left open, or fitted with louvres to exclude rain, and broadly-projecting eaves. The parapet will conceal this raised portion, which will serve as an exit for the sound of the bells. The bell-chamber windows, which would probably be retained for appearance sake, would in this case cease to serve the purpose of *sound*-windows, but would be either permanently or temporarily blocked. In an existing tower the same plan may be adopted, when practicable, the sound-windows being closed up, at least temporarily. (Example at Worcester Cathedral.) As an illustration of the advantage of this plan, a gentleman (a celebrated change-ringer, and a great authority on all matters connected with bells) was once on a visit to Lavenham, in Suffolk, and, while walking towards the church, observed that the famous tenor sounded even better than usual: he found later that a portion of the roof of the tower had been removed for repairs, and concluded

Bell Towers and

(no doubt, correctly) that the improved tone of the bell was due to this cause.

Where there is a spire with openings at its base, it would only be necessary to prevent the sound issuing in any volume through the bell-chamber windows; taking care, of course, to exclude rain from the openings at the base of the spire.

Any of the above methods of treatment will be found effectual in mitigating the harsh sound of bells in the immediate neighbourhood of the tower; in equalizing the tones of all the bells; and in causing the sound of the bells to travel to a greater distance, because the sound-waves which formerly were directed down into the street would be directed upwards, or horizontally, and would so reinforce the other sound-waves that the music of the bells would be heard further off than before.

THE ARRANGEMENT AND FURNITURE OF RINGING CHAMBERS.

In turning to the subject of the arrangement and furniture of the ringing chamber,

Bell Hanging

it would be ungracious not to acknowledge, thankfully, how much improvement has been already effected in this direction, in very many towers throughout the country, during recent years. The following suggestions, therefore, are made, not with the view of criticising what has already been done—and well done—elsewhere; but with the hope of awakening some care for the appearance of the ringing chamber, and the convenience of those who use it, in towers where, as yet, little or nothing has been accomplished under this head.

Speaking generally, simplicity and cleanliness are the chief things to be secured in the arrangement of a ringing chamber. The aspect of it should be attractive and not repellent; and though nothing suggestive of luxury or excessive adornment will be recommended here, still the ringing chamber should be made to present to the ringer an air of comfort and convenience somewhat more real than can be conveyed by the sight of rough and naked walls and bare boards.

Bell Towers and

The best way of treating the ceiling of the ringing chamber being dealt with in another section, we may turn our attention at once to

I.—THE WALLS.

The builders of our church towers, in old times more especially, rarely took pains to trim and point their work on the inner faces of the walls; these present, therefore, more frequently than not, a rough, uneven surface of rubble, which, when allowed to remain naked, has a very rugged, unsightly appearance. In the absence of finished stone or flint work, no harm is done by covering such rough walls with a good coating of suitable plaster, afterwards distempered to a hue somewhat more warm and restful to the eye than is afforded by mere whitewash. The six or seven feet of wall immediately above the floor will require special treatment to prevent the colour being rubbed off. A light wood moulding run round the walls, at a height of about six feet from the floor, has a good effect; and the wall-space between it

Bell Hanging

and the floor can be treated in various ways, according to taste. Wood panelling should be avoided; but the plaster can be made to take a coat or two of paint of approved colour; or the space can be panelled out with some kind of close-woven matting. One wall should be furnished with a sufficient number of coat and hat pegs. All openings in the walls should be provided with curtain screens; and, in cases where the ringing chamber is open to the church, it is well to have a drop-curtain, which can be raised or lowered at pleasure, to cover the whole opening of the arch down to the floor of the ringing chamber. A notice-board, on which to post belfry and association rules, and other documents required for the information of the ringers, should be provided. In large chambers corner-cupboards can be conveniently arranged, improve the appearance of the apartment, and are extremely useful for many purposes, as, for instance, lockers in which to keep tools, spare ropes, the safety lantern (which should form part of the equipment of

Bell Towers and

every tower), and other necessary articles; washing cupboard, etc. In small chambers, the boxes on which the ringers of the heavy bells stand may be made as lock-up chests to serve the former purpose.

II.—THE FLOOR.

Where the ringing chamber is on the same ground level as the rest of the church, its floor will either be paved, or laid with tiles, or, perhaps, with wood-pavement. In the case of stone or tile pavement, some kind of carpet-covering, or linoleum, is desirable. Where the floor of the chamber is higher up the tower, and is properly laid with stout boards, ploughed and tongued together, a covering is only necessary to correct resonance, though coir-matting, carpet, or linoleum will add to the cheerful appearance of the chamber, and is warm in winter. Where the floor is badly laid, some covering of the sort is absolutely necessary to prevent draughts rushing up from below through defective joints. Soft mats, for the bight of the rope

Bell Hanging

to fall on in ringing, should be provided according to the number of bells in the tower ; because the rattle of the ropes on a hard floor prevents the striking of the bells above from being distinctly heard, and unduly wears the ropes themselves, where they strike the floor.

III.—OTHER FURNITURE.

In many chambers the accommodation in the way of seats is very limited and imperfect. It is true that some towers are of such small size that almost the whole available space is taken up by the circle of ropes ; but in such cases, at least half-a-dozen chairs, of the usual Church pattern, should be available for use where they can be squeezed in. Advantage can also be taken of window ledges, and other recesses in the walls, where they exist, to provide seats. All ledges of masonry used for this purpose should be cushioned. In more roomy chambers, besides a few chairs, one or two benches with rail-backs should be made and placed along the wall where they will be well out of the

way of the ropes. In a well-appointed ringing chamber, water, soap, and clean towels will be kept by the steeple-keeper ready for use, and it is very desirable that such conveniences should be provided where possible. A small, but strong, table is very useful in the ringing chamber, if there is room for it; where the circle of ropes is wide, the table may be conveniently placed in the centre of the floor.

IV.—LIGHTING.

Where gas or electricity is laid on, the lights should be at such a height from the floor as to avoid dazzling the eyes of the ringers while at the ropes. A central suspended light is best.

X.

CHURCH BELLS FORM THE SUBJECT OF A LEADING ARTICLE WHICH APPEARED IN *THE TIMES* OF SATURDAY, SEPTEMBER 23RD, 1899, AND WHICH IS HERE GIVEN, TOGETHER WITH PART OF THE CORRESPONDENCE TO WHICH IT GAVE RISE.

AMONG the "ornaments" or accessories of churches and of Divine worship few possessions of such value are often so little regarded, if not entirely neglected, as the church bells. Far away out of sight in windy towers, accessible only by narrow winding staircases or dangerous ladders, hang peals of bells, which, with their fittings, cost many hundreds of pounds, unvisited and uncared for by clergy or churchwardens, who grudge even the small annual expenditure that is necessary to keep them in good order for ringing, till some day or other it is discovered that they are unringable or even dangerous, and large sums have

Bell Towers and

to be expended for want of the "stitch in time." The desire for what is sometimes miscalled "restoration," or at least for order and decency in the fabric and the fittings of the church, does not in all cases extend to the belfry. Our modern architects take even less trouble than those of older days to provide easy access to the ringing chamber and good accommodation for bells and ringers, of whose requirements they are, as a rule, ignorant. The clergy, with a few exceptions, take little interest in their bells; the churchwardens know nothing about them, and care less; the sexton, whose duty it is to look after them, and see that ropes, wheels, bearings, and frame are in proper order, saves himself all the trouble he can; and so the process of neglect goes on. It is not an unknown thing to find a church beautifully restored and cared for, with a good organ and a competent choir, but with the tower, which is, after all, part of the consecrated building, in a condition of disgraceful neglect. The time, indeed, has not long passed when this could be said of

Bell Hanging

some cathedrals, even of the Abbey itself. St. Paul's Cathedral, in this as in other respects, sets a better example. In its north-western tower hangs a heavy "ring" of twelve bells, in first-rate order and rung by competent change-ringers—the finest ringing peal in England, and therefore in the world. It cannot be said, however, that our cathedral chapters, as a rule, set the same example to the parochial clergy in regard to church bells as they do in regard to church music. The atmosphere of a cathedral close is not very congenial to reform.

Yet within the present generation there has been, and is still going on, an active movement for reform both in belfries and among ringers. The days are not far distant when change-ringing was classed among lower forms of sport; when the belfry was too often in close connection with the public-house; and when ringers bore an ill-reputation for good conduct and sobriety. That this is now a thing of the past is due largely to a revival of the art of change-ringing, and to the

Bell Towers and

formation all over the country of diocesan or county societies for the encouragement of change-ringing and the reform of belfries. Some of the clergy have become practical change-ringers, and their constant presence in the belfry does more perhaps than any outward regulations to improve the *morale* of their ringers. The art of change-ringing, requiring as it does patience, perseverance, steadiness, and concentration, and, above all, sobriety, is no bad training for those who take it up. It was once, we are told, a fashionable pastime. It has, even now, its literary organs. A "Central Council of Church Bell Ringers," consisting of delegates from the various guilds, societies, or associations, meets annually in London or some provincial centre for the discussion of matters concerning the ringing art. This council is said to be representative of some thirty thousand ringers, a body of respectable men well disposed to the Church and to the clergy, whose allegiance is by no means to be despised by Church authorities. Among other useful works which this Council

Bell Hanging

has taken in hand is the dissemination of knowledge respecting the proper care of bells and of belfries, and particularly of well-ascertained means for diminishing, without silencing, the sound of bells in close proximity to houses. The distant sound of "bells at evening pealing," or of the curfew "over some wide-watered shore swinging slow with sullen roar," is one thing; but quite another is the hammering crash of a noisy peal above the streets and houses of a town. The natural annoyance which finds vent in indignant complaints of the "bell nuisance" might often, in justice, be diverted from those who ring the bells, or allow them to be rung, to those who neglect proper precautions to soften and modify their sound. There is, we believe, no reason why the bells of any town church should cause more annoyance than those of a country village, or than the bells of St. Paul's Cathedral as their music rolls out above the roar of London streets. The public have a right to require from clergy, churchwardens, or others responsible for steeples and bells,

Bell Towers and

that the architectural arrangements of the bell-chamber shall be such as enable the bells to be rung with a *minimum* of annoyance to the neighbourhood.

That church bells should be silenced few, we imagine, would desire. The "sound of the church-going bell," familiar to many from their childhood, has in it a suggestion of home; and to those who have lived at home within sound of a melodious peal, its absence aggravates the bitterness of exile. Bells, too, have from very early times in England been associated with the life of the people. We still expect them to ring joyfully at a wedding and toll mournfully for a funeral; and the "passing bell," no longer as a rule at the time of death, but shortly after it, is in general use. We can still appreciate Shakespeare's illustration of the "first bringer of unwelcome news"—

"his tongue

Sounds ever after as a sullen bell

Remember'd knolling a departing friend."

The curfew survives here and there by

Bell Hanging

force of custom, though its meaning is lost. The "harvest" or "gleaning" bells, to call labourers and gleaners into the fields, have not long disappeared, if they have yet disappeared, from some country parishes. The "market bell," originally rung as a signal for selling to commence, so as to guard against forestalling, is still rung at noon on market days at Oundle; and at Nottingham a bell given by a washerwoman, with a bequest to provide for its being rung at four o'clock in the morning to call the washerwomen of the town to their work, is still (or was till recently) rung during part of the year at the more reasonable hour of six. The "fire bell" is still common; but the "storm" or "tempest" bell, to ward off thunder—perhaps from its supposed power to drive away evil spirits; the "oven bell," to announce that the manor oven was heated, to which the tenants had to bring their bread; or the "pancake bell," rung on Shrove Tuesday as a signal to housewives to use up all their grease and dripping before the Lenten fast, have disappeared. In

Bell Towers and

remote country parishes there are still curious survivals of such customs in the ringing of bells at odd times without apparent reason. Occasions of great public rejoicing have always been celebrated by the ringing of bells. Her Majesty's Jubilee, for instance, in 1887, and the celebration of the sixtieth year of her reign in 1897, gave occasion for much ringing of peals, and also to the re-hanging and restoration of church bells all over the country. The church bells of England have their part both in national and in social life. If their more frequent use, due to the revived enthusiasm for change-ringing, has here and there aroused murmurs of annoyance, it is for those who have the charge of them to see that causes of annoyance are removed, as they can be without recourse to such drastic methods as silencing the bells or discouraging the art whose object is to make the best use of them.

(To the Editor of *The Times*.)

SIR,—Absence from home has delayed my seeing the encouraging and accurate article on church bells which

Bell Hanging

appeared in your issue of last Saturday. I crave permission to amplify on one or two points the information it conveys. As a practical ringer of some forty years' experience over a tolerably comprehensive area, I can corroborate your remarks as to the radical change for the better in the ringer and the wholly incommensurate improvement in the condition of church bells and their accessories. The explanation is simple. The extraordinary spread of scientific change-ringing, attended by a notable advance in the social position of ringers as a class, has been due chiefly to their own exertions. Had Church authorities led the way, naturally the belfry, not the ringer, would have first improved; a sequence distinctly exceptional.

For several years the Central Council of Church Bell Ringers pressed upon Church Congress the desirability of considering this subject, but fruitlessly. Foiled in thus drawing attention to the neglected state of so many of our fine bells, the Council set to work to obtain, by means of printed questions sent to the leading ringers of each tower, a return of the actual condition of every "ring" of eight bells and upwards throughout the country; to be followed, perhaps, by a similar inquiry in respect of the smaller "rings." This return, when by-and-by published, will, it is hoped, do something towards opening the eyes of Church authorities and the public to the need of reasonable expenditure on keeping valuable instruments in order and their surroundings decently clean. I often marvel at the persistency with which ringers follow their art when, as frequently, it is amid the discourag-

Bell Towers and

ing surroundings of neglected, and therefore laborious, bells and of dirt-laden belfries; but I do not marvel that, seldom favoured by the intelligent sympathy and criticism which even an unmusical clergyman educates himself to bestow on his choir, they are, as a rule, irregular churchgoers. An elderly vicar in my neighbourhood was urgent that his ringers should attend service, and their leader hinted that an occasional pastoral visit to the belfry might be productive of an improvement in this direction. On next meeting the man, the vicar said he had made an honest effort to get up the tower, but that the dangerous state of the steps and the dust with which his Sunday coat was being covered had necessitated a retreat.

In regard to the nuisance of noisy bells, you rightly say there is no reason for this. Unfortunately, architects, wedded to a false tradition, invariably assume that bells, to be properly heard, should be hung on a level with the window openings; the result in the immediate vicinity being a deafening clang, with an undue preponderance of the tones of those bells which hang nearest the listener. The ideal tower is one with no sound-windows, but with an open top. This desideratum is most nearly approached by building up the windows—of course, behind the louvres—even if necessary to the spring of their arched heads, so that the sound from the bells when mouth upwards may have to rise before obtaining a vent. This procedure is well worth its cost, for the result is effectually to soften the tones to the bystander, while making them at the same time more distinct, if slightly less loud,

Bell Hanging

at a distance. Loughborough church is a notable example of the success of this treatment.

During the past ten years bell-hangers, under some pressure, have come round to substituting, as far as possible, iron for wood in their work, which is consequently now more costly, but far more satisfactory from every point of view. Less generally successful has been the endeavour to induce architects to admit the well-established advantages of using the bell-frame as an effective cross-bracing to the tower instead of leaving it loose on projecting corbels, as of old, to batter and spread the walls.

Bell-founding itself is probably on the eve of a great change. Hitherto it has been deemed sufficient to tune a "ring" of bells by more or less accurately adjusting the note given out by the sound-bow, or thick part of the rim. But it is well-known to experts that every bell sounds at least three distinct notes, and yet perfect harmony between these has but rarely been attempted or obtained. Of late, however, elaborate experiment, mainly initiated under the able direction of the Rev. Canon Simpson, whose letter you print to-day, has demonstrated the possibility of removing metal from the inside of a bell in such manner as to bring its various sound-zones into accurate accord with a standard series of large tuning-forks. Thus each bell gives out a true and melodious chord in place of the usual discordant clang, an effect which has only occasionally and by chance been achieved before in the case of a single bell, and, as Mr. Simpson says, probably never in the case of a whole "ring." Some time ago a

Bell Towers and

ringer, standing with an unsympathetic friend near a tower in which a band of skilled performers were hard at work, remarked that change-ringing was a most difficult acquirement, to which his companion replied that he was sorry that it was not altogether impossible, thereby, without doubt, expressing the feelings of a considerable section of the public.

Seeing, however, that, as you justly point out, large sums of money have been—and assuredly will continue to be—spent on new bells, it seems little short of folly to grudge such moderate outlay as will suffice to keep them in good order and their ringers in reasonable comfort; nor, in face of the deep-rooted national love of bell-music, need grumblers urge objections which, as has been shown, can in great measure be removed. Add to this the not inappreciable gain to the Church in the thereby increased loyal adhesion of a body of respectable men (whose numbers you, Sir, certainly underrate at 30,000) already by their occupation if not by belief well-disposed towards her, moving, too, for the most part in that stratum of society which questions much the benefits of Establishment, and a case is surely made out for more liberal attention from those to whom the care of our valuable church bells is entrusted.

I am, Sir, your obedient servant,

ARTHUR HEYWOOD,
*President of Central Council
of Church Bell Ringers.*

September 30th, 1899.

Bell Hanging

THE TUNING OF CHURCH BELLS.

(To the Editor of *The Times*.)

SIR,—The appearance of your timely and interesting leading article on church bells induces me to hope that you may allow me to put in an earnest plea in behalf of the better tuning of bells.

As one who has made this matter a study for more than a quarter of a century, I make bold to say that the ignorance of this art on the part of bellfounders and tuners generally is really wonderful, and accounts to a large extent for the existence of such a phrase as the “bell nuisance.”

Some few years ago, in an article in the *Pall Mall Gazette*, I stated my belief that there did not exist in England a single peal of really properly tuned bells.

To justify this statement would need a larger space than I dare ask you to give me. But, shortly, the case is this. In every bell there are three notes, which ought to be in unison with each other, in order that the bell should give out a pure tone. But bell-tuners have been content to deal with only one of these, leaving the others to take care of themselves, always to the detriment of the tone, and, in the case of small bells, oftentimes to its utter confusion.

This need not be so; the whole problem has of late years been thoroughly mastered by at least one well-known founder. I have lately heard a grand peal of ten bells, in which all the tones and sub-tones were in perfect harmony, and the result was music.

Bell Towers and

I have no pecuniary interest in this matter, but I am very anxious to forward a much-needed reform in a matter of very wide interest, and I should be grateful to you, Sir, if you would allow this letter to appear in your influential columns.

Yours faithfully,

A. B. SIMPSON,
*Rector of Fittleworth and
Prebendary of Chichester.*

Fittleworth Rectory, Sussex,
September 25th, 1899.

CHURCH BELLS.

(To the Editor of *The Times*.)

SIR,—Sir Arthur Heywood, in his letter in your issue of the 30th ult., advances views which raise a point of such serious importance to the welfare of our ancient church towers that this society hopes you will allow the other side of the case to be stated. He says:—

“ During the past ten years bell-hangers, under some pressure, have come round to substituting, as far as possible, iron for wood in their work, which is consequently now more costly, but far more satisfactory from every point of view. Less generally successful has been the endeavour to induce architects to admit the well-established advantages of using the bell-frame

Bell Hanging

as an effective cross-bracing to the tower instead of leaving it loose on projecting corbels, as of old, to batter and spread the walls."

Sir Arthur Heywood, from his position of president of the Central Council of Church Bell Ringers, must be accepted as an authority upon the question of how bells should be hung from the bell-ringers' point of view, but we are convinced that he has dismissed the traditional method of the mediæval builders too lightly, and also that their method, if properly carried out, is quite satisfactory from the ringers' point of view.

No one can deny that oscillation and vibration are set up by the ringing of a peal of bells. If rigid iron cages are used and cross-braced to the tower, the whole movement is received directly by the masonry or brickwork, whereas an oak cage of a reasonable height, properly constructed, relieves the walling of some strain, as it is taken by the natural spring in the timber, provided the cage stands clear of the wall all round at the level of its upper beams.

We are aware that in time, partly through shrinkage of the timber, the frames work loose, and the bell-ringers usually take the simple expedient of driving in wedges between these upper beams and the walls, and this has caused the destruction of very many towers; but, after all, this is in effect somewhat similar to the iron frame advocated by Sir Arthur Heywood. These timber cages can in all cases be tightened up so as to avoid the necessity for the bell-ringers' wedges.

I think it will be obvious to all, that the lower down the tower the support of the bell-cage is taken, the less

Bell Towers and

strain the tower will have to receive, and also that timber is a better material for deadening the vibration than metal.

I am, Sir, your obedient servant,

THACKERAY TURNER,
Secretary.

The Society for the Protection of Ancient Buildings,
October 6th, 1899.

(To the Editor of *The Times*.)

SIR,—I cannot refrain from writing again to warn church-builders of all kinds against being misled by Mr. Thackeray Turner. This is a mechanical question which I have been dealing with in every way for sixty years, both as a builder and a bell-designer, including bell-hanging. The only right way is to build the frames of iron fast into the walls, which prevents all the battering and also the constant shrinking and swelling of wooden frames, which are, or were, the real causes of the destruction of most old towers by bell-ringers. Let any such great bellfounders and hangers as Messrs. Taylor, of Loughborough, give you their experience about it, and no reasonable or capable mathematical reader will doubt. I cannot write more now.

Yours obediently,

GRIMTHORPE.

Batch-wood, St. Albans,
October 12th, 1899.

Bell Hanging

(To the Editor of *The Times*.)

SIR,—May I ask space to reply to the letter, in your issue of October 11th, of the secretary of the Society for the Protection of Ancient Buildings, who opposes with the time-worn arguments for unsecured timber bell-frames the modern iron one, bolted in as cross-bracing to the tower? Wood was formerly the universal material for every sort of framing—ships, bridges, machinery, railway stock—and, in spite of all melancholy forebodings, iron and steel have been advantageously substituted. The same process is tardily taking place in bell-hanging. Mr. Turner rather implies that I regard the matter exclusively from the ringers' point of view. This is not so. I have, indeed, had more to do with building than with bell-hanging. The stability of the tower interests me as an engineer's question, and I advocate bell-frames bolted right through the walls more for the sake of the structure than of the bells. Mr. Turner says: "It will be obvious to all that the lower down the tower the support of the bell-cage is taken, the less strain the tower will have to receive." So obvious, that in St. Hugh's tower at Lincoln an eminent architect was led to reduce the theory *ad absurdum* by carrying the supports of the frame down to the ground level, thus causing the bells to hang in an independent and rickety structure 70 feet high. That which is obvious has seldom been the subject of careful inquiry; hence many errors. The wedge between frame and wall, so justly condemned by Mr Turner, was, of course, in evidence here, as it

Bell Towers

will continue to be, despite the most stringent injunctions, wherever unsecured bell-frames are to be found—of itself almost a sufficient reason for their disuse. Yet wedges, mischievous as they are, often save the walls from the worse thumps of a loose frame.

The slow oscillations set up by swinging bells—not at all the rapid vibrations of revolving machinery—seem to have been but little studied, and are extremely complex, partly owing to the axes of some of the bells being at right-angles to others, partly to the continuously changing order of their swing. With an unsecured frame these varying forces at one time counteract one another, and again accumulate to produce surprising oscillations of the whole tower. It is this cumulative action which does the mischief. The fast-bolted frame, being part of the mass of the tower, readily resists the feeble initial oscillations, which consequently have no tendency to magnify. Argument, unfortunately, never carries conviction except to the ignorant; but if any architect will, as I have often done, stand against bell-frames of various kinds, in various conditions of repair, when the bells are being rung, and note carefully all he sees and feels, he may probably come to favour my contention that most of the harm to towers is due to unsecured frames, and to recognise the steady effect of bolting them, both above and below the bells, to, or if necessary through, the walls.

I am, Sir, your obedient servant,

ARTHUR HEYWOOD.

October 12th, 1899.

XI.

A REPORT UPON THE CONDITION OF OUR CHURCH BELLS, 1906.

THE Central Council of Church Bell-Ringers, in view of the dilapidated condition of many "rings" of church bells, decided some time ago to institute an enquiry with the object of ascertaining, as far as possible, the number of cases of neglect, and also of collecting information in regard to belfries and ringing generally. The results are given below. It should be stated that the enquiry only extended to "rings" of eight bells and upwards, these being by far the most important. To have included "rings" of five and six bells would have been too extensive an undertaking, but it may be concluded, with a fair probability of accuracy, that at least as great a proportion of the smaller "rings" are in need of attention as has proved to be the case with the larger.

Bell Towers and

It is by no means certain that there are not some "rings" of eight which have escaped the attention of the Council, as they have had to rely mainly upon lists of towers furnished by the various County and Diocesan Ringing Associations, whose areas, although fairly covering all the English dioceses, yet do not wholly do so. The omitted towers, however, cannot be more than a small fraction.

The Council issued circulars addressed to the representative ringers of 1,055 towers. Each circular contained a list of questions, with a request that these should be carefully answered, and the accuracy of the answers vouched for by the signatures of two of the leading ringers of the tower.

To the 1,055 circulars, 940 replies were received. The information thus obtained is tabulated below.

1.—In 89 per cent. of towers the bells are "pealable" (*i.e.*, can be rung through 5,000 changes).

In 11 per cent. of towers the bells are not "pealable."

Bell Hanging

In 6 per cent. of towers the bells are unringable.

2.—In 22 per cent. of towers “clocking” is allowed. (This consists in pulling the clapper against the bell, whereby innumerable bells have been cracked.)

3.—In 4 per cent. of towers one or more bells are reported dangerously worn by clapper, and, consequently, need quarter-turning.

4.—In 8 per cent. of towers repairs have been urged on the Church authorities. (In only 27 per cent. of the cases where repairs have been urged has anything been done.)

5.—In 3 per cent. of towers the authorities are reported to look thoroughly after the bells and belfry.

6.—In 3 per cent. of towers workmen who were not professional bell-hangers have been employed on repairs, usually with injurious results.

7.—In 21 per cent. of towers the bells are in iron frames, which are in all ways preferable, particularly in regard to economy of repair.

Bell Towers and

8.—In 7 per cent. of towers a chiming apparatus is fitted.

9.—In 77 per cent. of towers there is scientific change-ringing.

10.—In 58 per cent. of towers there is Sunday ringing for two services.

In 10 per cent. of towers there is Sunday ringing for one service only.

In 13 per cent. of towers there is Sunday ringing occasionally.

In 19 per cent. of towers there is Sunday ringing never.

11.—In 77 per cent. of towers there is a regular practice night.

In respect of the above particulars, it may be remarked on No. 1 that experience unfortunately shews that, of "rings" returned as fit for peals, not a few can scarcely be properly deemed so.

Undoubtedly there is considerable ignorance on the part of Church authorities of the value of their bells, and of the risks incurred by neglect of proper repairs. In 1890 the Central Council of Church Bell-Ringers was

Bell Hanging

formed, which now unites all the more important County and Diocesan Ringing Associations, to the number of about forty. These latter are represented on the Council by nearly 100 delegates, who meet each year to discuss all matters affecting bells and ringers. Under the auspices of the Council, various pamphlets have been published on the care of bells, the art of change-ringing, and the management of ringers. Yet the above returns shew that, while matters have greatly improved, there remain many cases where apathy, impecuniosity, and want of technical knowledge, either singly or collectively, are permitting fine "rings" of bells to fall into decay; and even where some attempt at repair is made, too often it is forgotten that ringers in their Sunday clothes deserve a clean, well-lit, and properly ventilated ringing chamber, and that the sound exits of the belfry should be so adjusted as to give an even and modulated harmony, in place of the far more frequent ear-piercing din which is the result of the ignoring by

Bell Towers

nearly all architects of the fact that a bell gives out its note when mouth upwards, and of the desideratum that this note shall be directed towards the sky, and not have a chance of exit at the level of the inverted bell, or below it.

(Signed) ARTHUR HEYWOOD.

XII.

BELL RESTORATION AND THE NEED OF PRACTICAL ADVISERS.

A LETTER ADDRESSED TO "THE RINGING
WORLD" BY EDWARD P. O'MEARA.

*(Sometime Master of the Ancient Ringing Society of College
Youths, London.)*

THE present wave of bell restoration throughout the kingdom suggests to me something that might be worked into tangible form. At present incumbents are augmenting and restoring their "rings" of bells, with sometimes only a committee of church officials, who, knowing nothing of the practical or ringers' side of the question, often err through want of proper advice. I have had the pleasure of being at several re-openings lately, and it has struck me, upon more than one occasion, in what a haphazard manner the whole affair has been carried out. No competent ringer engineer has been asked to

Bell Towers and

assist with his advice, no architect with a knowledge of ringers' requirements (these gentlemen are few and far between) has been consulted, and the consequence is, in many cases, money wasted. I could give many instances, but one or two will suffice. A "ring" of bells in the city of London were "rehung" at an expense of some £200, but after the operation they went worse than before, and eventually another firm had to be called in, and a further sum of over £200 was spent, happily with better results. Here was a case where advice would have been useful, and much more might have been done with the money. Another instance I will name, where most of the bells were recast, in a prominent country church, and were augmented to a "ring" of twelve. Here the authorities passed the work, when the tenor bell, to say nothing of the others, was such that no engineer ringer, with any ear at all, would have passed it, or permitted it to go into the steeple. There are many men throughout the country who would be pleased

Bell Hanging

to give sound advice and assistance of this nature if they were asked—I mean capable men who are in no way connected with any firm of bellfounders or bell-hangers, who are ringers as well as engineers, and who know a good bell when they hear one. These are the men who would be useful. I have had the privilege myself of helping rectors upon more than one occasion, and I know of many much more capable than I am, who would willingly give their services, if asked, in what is a matter of vital importance to ringers generally. Perhaps if some member of the Central Council would bring the matter forward, some good might be done which would help incumbents, who have no knowledge of the matter themselves. There is much good work being done in various centres by committees who have the advice of practical men of the right sort, but I know of instances where ringers did not like to speak about indifferent work, because they were not asked for an opinion, and the work has consequently been passed and paid for. Of course, there

Bell Towers

is any amount of work, excellently done, where all has been as it should be, and often without the practical advice I am advocating, but it would be invidious to mention names or places in a letter, which will, I hope, bring out the views of others, who are more capable to speak than myself. On the other hand, I have seen frames put in which are much too light for the weight of metal to be carried, and freak bearings about which the least said the better. I think this matter is of very great importance at the present time, or I would not have so far encroached upon your valuable space.

1914.

E. P. O'M.



KQ-655-988

